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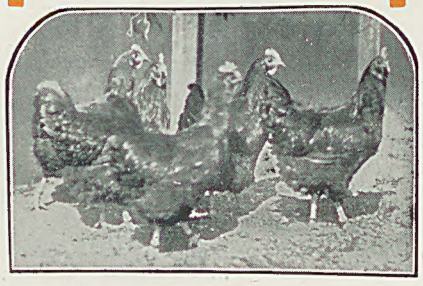

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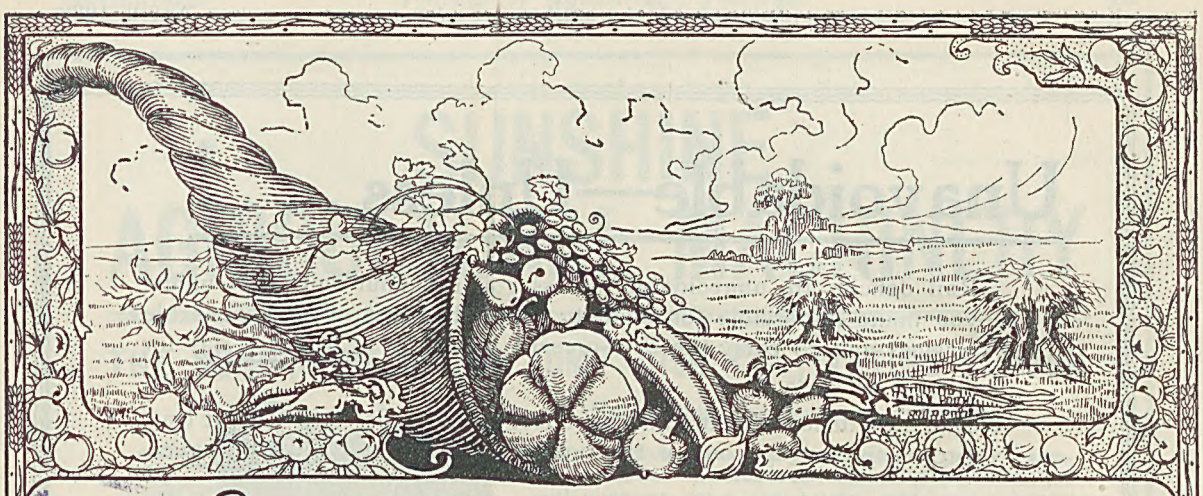

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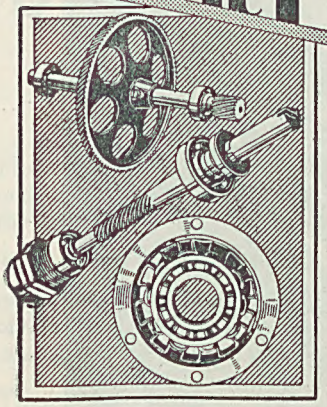

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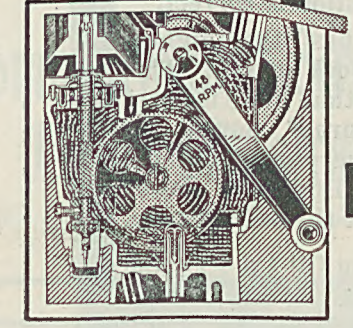

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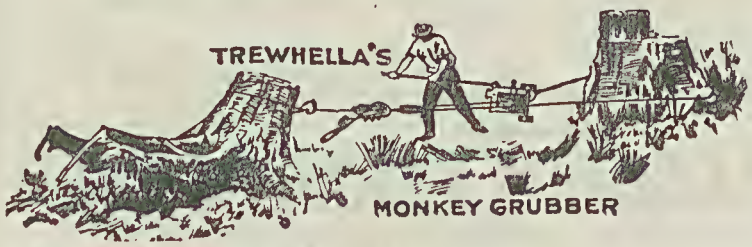

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The Journal of the DEPARTMENT of AGRICULTURE of VICTORIA

The Tobacco-Growing Industry

An address delivered at the Annual Convention of the Chamber of Agriculture by Mr. H. A. Mullett, B.Agr.Sc., Agricultural Superintendent.

AUSTRALIA consumes annually about 28,500,000 lb. of tobacco, valued, unmanufactured, at £2,400,000. Of this quantity 94 per cent. is imported from overseas, mainly from the United States of America, the balance being grown in Australia, principally in Victoria, New South Wales, and Queensland. The imported tobacco is 90 per cent. bright flue-cured type, but the home-grown leaf is mostly of darker grade.

That a country with the natural resources of Australia should have to go overseas for such a large proportion of this product of the soil is surprising, and, at a time when it is important to reduce imports to a minimum, it is pertinent to ask the reason and also to inquire into what steps should be taken to effect a change.

There is no doubt that one of the principal reasons why the industry has never made headway in the past is that, for various reasons, manufacturers preferred the imported article to the local. This preference was maintained even though the heavy duty paid on imported tobacco for years made it dearer than Australian leaf. However, Australian manufacturers regularly purchased about 6 per cent. of their requirements in Australia, and used the leaf mainly for blending purposes.

For many years the prices paid here for the various grades, taken in relation to the acreage yield, have favoured the production of dark tobacco, because growers found that owing to the heavier yields of this type, which is grown on rich alluvial flats, their net returns were greater. Thus the growers of bright leaf, which requires poor soils and gives moderate yields, remained relatively few. Latterly the policy has been changed, and growers of bright tobacco, stimulated by a system of bonuses, have increased in numbers.

Last year the industry received a sudden and powerful stimulus from the introduction of very heavy duties on imported leaf. Australian leaf for the first time was keenly sought, and competition was so free that the great proportion of leaf was purchased in bulk without grading being required, at prices estimated at 3s. per lb., as compared with 1s. 9d. per lb. average for all grades the previous year. In Victoria this high price attracted some 1,200 new growers to an industry in which 600 were previously engaged. This suggests that the quantity of local leaf grown depends mainly on the price paid.

My first point is that if the industry is to produce the whole of our local requirements, it must be made sufficiently attractive financially, and the second is that the purchasing policy of the manufacturers should pay some regard to making it more profitable to grow the grade of tobacco required than any other kind. More cannot be said on this aspect without entering upon a discussion of the incidence of the tariff and excise on tobacco, a very contentious subject at the moment.

Assuming the industry can be established upon a profitable basis for the individual grower, it is then necessary to consider whether sufficient bright tobacco of the requisite

quality to replace the imports can be grown, and ways and means by which this may be done.

Quality in tobacco is dependent upon a number of factors, and one of them is soil. It has been argued that Australia contains little or no soil suitable for the growth of high-grade bright flue-cured tobacco, but it is difficult to believe that the relatively small area of the right kind of soils necessary to raise 22½ million pounds weight of tobacco—that is to say, 30,000 to 40,000 acres—could not be found in a country so vast in extent and with such a wide climatic range as the Australian continent.

A year or two back it was put forward quite seriously that proof had been obtained that there was a eucalyptus taint in Australian soils, and that this affected the aroma of tobacco. This is known as the Phelandrene theory, but is discredited to-day. Eucalyptus taint in the soil never affected delicately flavoured primary products like wine, butter, cheese, or fruit, nor has it been discovered in bread made from our wheat. In all these commodities human enterprise has shown that upon appropriate soils delicately-flavoured commodities can be raised free from objectionable taints. True, the soil has a marked influence upon products such as wine, but only as to its type, not as to soundness, and so it is with tobacco. In both commodities faulty flavours and aroma find their origin in faulty technique and not in the soil. Bright flue-cured tobacco can be grown on Australian soils, and the view is put that the production of satisfactory smoking quality in tobacco grown on them is purely a technical function within the control of the grower and of the manufacturer, and that close co-operation between the two is essential for success.

Departmental expert opinion regards the Pomonal and the Stratford-Bairnsdale areas as being sufficiently large in themselves to provide Australia with the whole of the bright flue-cured tobacco now imported, and is satisfied that in these environments sound smokable leaf can be raised. Other areas much greater in extent are to be found in the light soils along the Queensland coast, and it is from this locality that Victoria can expect the keenest competition in the future.

Sound bright Australian tobacco is not precisely like American Virginian type tobacco. It has its own characteristics, as has the tobacco of every other environment in the world; but the difference between Virginian and Australian is not so very great, provided that the tobacco is properly grown, cured, re-ordered, prized, and aged. Certainly the difference is enough to cause manufacturers concern as to the immediate effect on trade if pure Australian tobacco were suddenly offered the public without alternative, but blended in moderate percentages with Virginian the difference is not sufficiently noticeable to attract attention.

Sound Australian bright tobacco certainly possesses no feature that should prevent public taste from being gradually shifted to it in a few years by the method of slowly increasing the proportion of Australian leaf in the blend.

The percentage of high-grade bright tobacco now being produced is not high, but it can be steadily increased by co-operative effort between the grower and the buyer.

The industry in Australia suffers from a number of disabilities, and perhaps the greatest of these is blue mould, a damping off disease which plays havoc with the young seedlings, and sometimes affects the growing crop, and it may do this at practically any stage of maturity. The damage done by this pest is peculiar to Australia, and its incidence governs the economic success of the industry, because its effect is so severe that very frequently growers are at their wit's end to secure sufficient seedlings for planting out. The spores of the disease may be transmitted in the tobacco seed itself, or by the air. Infection through seed can, of course, be prevented by the use of seed known to have been grown on plants free from blue mould, but experience has shown that this precaution may not prevent the plants later becoming infected. Last year the Commonwealth Government imported considerable quantities of tobacco seed from the United States of America, which country is known to be blue mould free. A plot of this seed was sown in Gippsland, eight miles distant from any other tobacco area. The plants remained free for a considerable time, but eventually became heavily infected. The spores of the disease must have been introduced either by air currents or accidentally by human agency, despite reasonable precautions.

The vulnerability to blue mould of tobacco grown from disease-free seed raises considerable doubt as to the practical effectiveness of this method of controlling the disease while infection from other sources continues to be so easy. Apart from seed, the principal source

[*Herald* photo.

Harvesting tobacco at Eurobin, Victoria.

of infection undoubtedly is from spores produced from over-wintering plants. Tobacco areas during the winter contain considerable infective material of this character, and growers are urged to systematically destroy such plants whether apparently diseased or not. The work must be thoroughly done, as a few neglected diseased plants are sufficient to spread the infection throughout a whole district, and in turn, perhaps, a whole State.

A crop which has been infected with mould usually presents a patchy appearance, with frequent misses and great irregularity of growth. Any such irregularity arising from whatever cause has a detrimental effect on the quality of the crop, because it does not ripen evenly.

Until this disease is conquered, the industry must possess a considerable instability in respect of the quantity of tobacco produced and its quality. Prevention of this disease is therefore the most important field for research for the scientific staff of the Commonwealth Tobacco Investigation.

To produce bright flue-cured tobacco of Virginian type and of satisfactory smoking quality, it is necessary to select a light sandy soil of sufficient depth and raise on it an even stand of quickly matured plants of the right variety. Hickory Pryor, Gold Leaf, White Stem Oronoco, Yellow Pryor, Conqueror, Spotted Gum, Dungowan, and Warne are all capable of producing bright tobacco, and are named in descending order of their capacity to produce bright leaf.

The greatest care in the selection of individual seedlings is necessary to avoid producing dwarfed and runty plants, and the rigid exclusion of any at all defective is essential. Transplanting is a ticklish operation, and where a transplanter is used the tendency to measure success by the acreage sown daily instead of by the successful establishment of individual plants must be avoided.

Quick maturity must be forced by heavy dressings of water soluble phosphates, 5 to 7 cwt. per acre being recommended as of great assistance in the production of quality leaf.

On very light soils up to 150 lb. per acre of dried blood should be used. Excessive doses of nitrogenous fertilizers, which produce coarse late growth, should be avoided. Even size of leaves and uniformity of ripening can be secured only by early topping and constant attention to suckering. Planting after 1st of January should be avoided.

One of the principal causes of faulty flavour is believed to be curing of immature leaves. Full flavoured tobacco of satisfactory aroma cannot be secured unless the leaves are properly matured at picking. The flue-curing of tobacco is of itself an art requiring the exercise of nice judgment and the use of a well-designed barn. The use of green-gum suckers as leaf hangers, and leaky flues, if not avoided, will detrimentally affect quality, and full control of all air vents, which must be of an adequate capacity, is necessary.

Adequate technical instruction in the flue-curing process is required if mistakes are to be avoided. Even then only practical experience will cultivate the judgment essential to handle tobacco in all its variations of condition and secure the highest uniformity of quality.

Those who have tried to smoke tobacco straight from the flue-curing barn know that at best it is raw and harsh to a considerable degree, and possesses little of that fragrant aromatic quality associated with mature tobacco; and the greater the percentage of immature leaf present the worse the smoke. Before tobacco will make a palatable smoke it must undergo a slow fermentation process. The nature of this process, and the extent to which it is carried, control to a very important degree flavour and aroma. This fermentation is mainly under the control of the manufacturer.

Before the fermentation can proceed the tobacco must be brought to a requisite degree of moisture, and air excluded by means of pressure. The extent to which the process is carried can be controlled, and time is a factor. The average time during which imported American tobacco has been aged before manufacture is between eighteen months and two years. Australian tobacco cannot be properly compared with imported tobacco unless it has been similarly treated, and for this purpose it is necessary for the manufacturers to use a re-ordering and prizing-down plant. In such a plant the tobacco is first dried by heating to a uniform temperature, then moistened by steam to a uniform moisture content, and later packed into hogsheads under pressure to age. Before the tobacco is finally made up certain patent sauces may be used to further develop the specific aromatic individuality intended for the brand.

The present system of marketing leaves much to be desired, and unless altered radically must be conducive to the production of tobacco of the greatest irregularity in respect of quality. The system followed is for the buyers to visit growers individually and make private treaties with them. There is no standard package and no standard grades; thus growers can form only very imperfect ideas of values, and find difficulty in standardizing their production methods, harvesting, and curing processes and grading.

Is it not time that tobacco was sold in the open market? Standard grades could be set up each season, and tobacco could then be graded in conformity with them, appraised by independent experts, and sold at auction. A year or two back broom corn was sold like tobacco is at present, but is now appraised and sold by auction.

Competition from Queensland is what Victorian growers must face. The industry is making rapid headway there, and already the question of standard grades is being actively discussed. The Australian market is strictly limited, hence in the long run only the most efficient methods of organization can survive.

To sum up, in my view Australia can supply her own requirements of bright flue-cured tobacco. She has suitable soils, and the application to the crop of proper technical methods will produce tobacco of the requisite quality. To secure this there must be the fullest co-operation between grower and manufacturer, as both have their part to play in influencing the quality of the finished product, and it would seem that a better system of marketing should be instituted. Competition from Queensland must be faced. There will always be a certain amount of instability in the industry while the blue mould problem remains unsolved. Research upon this problem is the industry's most pressing requirement.

Permanent Pasture Establishment

Autumn Sowings

By E. D. Cameron, B.Agr.Sc., Assistant Agrostologist.

Contented cows on a productive pasture.

WITH the advent of the autumn, farmers in many districts will be considering the advisability and possibility of converting inferior pasture and arable lands into permanent pasture. The important part pastures play in Victorian agriculture may be gauged from the fact that, according to the *Victorian Year-Book* for 1929-30, the 26,000,000 acres under pasture in that year yielded primary produce to the value of just over £23,000,000. In the same year £9,000,000 was derived from 8,000,000 acres of agricultural land devoted to cropping.

To the dairyman whose farm is situated in the higher rainfall areas of the State, the possession of fields which can carry stock for twelve months of the year is of paramount importance. The milk returns from a dairy farm serve, to some extent, as an index to its seasonal productivity, and any extremes of increase or decrease in these returns should be avoided, if possible. A high, uniform production from month to month is the most economical and payable proposition. Normally the spring months usher in grass growth with which the stock cannot cope. A question that arises is whether it is better to save this excess spring growth for future use or to deal with it by buying extra stock which have to be disposed of at the end of the spring, probably at a financial loss.

The saving of excess growth to be fed during the more trying winter and summer months is one means of ensuring more even production from the farm. This uniform production is most likely to be obtained on pastures consisting mainly of perennial plants, though it is possible to achieve it also on annual pastures where provision is made to supplement them by growing lucerne on other summer fodder crop.

To the farmer not so fortunately located from the rainfall stand-point, there is the ever-present problem of lowering the costs of production. Particularly has this been the case for the last two or three years, when prices of produce have been so very low. One likely method of reducing these costs is to increase the carrying capacity of the property by sowing down introduced grasses and

clovers on at least a portion of the area and adequately top-dressing such fields annually. By the encouragement of clovers in native pastures top-dressing alone may gradually give a profitable return, but the superphosphate will be more economically used if it is fed to more productive and palatable plants than our native species which are adapted to soils of low phosphate content and show comparatively little response to phosphatic fertilizers.

Having decided that the sowing down of permanent pastures is advisable, and that the operation is possible, it becomes a question as to the best methods to be adopted for their successful establishment and subsequent treatment, and it is with the object of offering a few timely hints and reminders that this article is written.

Thorough preparation of soil pays.

Soil Preparation.

The first point to be considered is that of the preparation of the soil. It must be admitted that this phase of pasture establishment is still considered by some to be one of minor importance, with the result that many pastures fail in their initial stages through poor germination of the seed, and through weed growth, and other adverse circumstances due to unfavorable soil conditions.

The successful grass-farmer realizes that to get maximum germination and production during the first and subsequent years, thorough preparation of the soil is necessary in order tc secure a clean seed-bed with a fine tilth and a firm surface.

The methods adopted vary slightly according to whether it is to be an autumn or spring sowing. With autumn sowings the land may have been previously ploughed and sown to a preliminary crop of either oats, potatoes, or millet. It is usually necessary then only to cultivate with a spring-tooth and light harrows to work to a fine and firm, but shallow, seed-bed. There is the alternative, however, of a short bare fallow period obtained by ploughing in the late spring or early summer. This has the advantage of allowing of intermittent cultivations which destroy successive crops of seedlings of annual weeds, thereby ensuring a clean seed-bed, free from weeds and weed seeds.

Continuous working also reduces the soil to a fine condition suitable to receive the small grass seeds. With regard to weeds, such as capeweed, dandelion, and rib grass, it must not be lost sight of that apart from their doubtful yielding capacity and nutritive value, the area occupied prevents the soil maintaining plants of a more desirable nature.

When new land is to be sown down to permanent pasture it is advisable, if practicable, to crop the area for a year or two before introducing the pasture mixture. While artificial fertilizing, practised during this period, puts the land into good heart for receiving the young grass, the cultivation renders the soil mellow and reasonably clean of weeds, and reduces it to a condition suitable for the germination and growth of pasture seeds and seedlings. A practice sometimes adopted is to sow down a permanent pasture mixture with a light cover crop to be fed off later. This has the advantage, apart from the extra feed produced, of protecting the young seedlings against extremes of heat or cold, and, in addition, the soil is compacted by the tramping of stock and made more suitable for pasture growth.

The consolidation of the soil is an important point which must not be overlooked. Young grass roots cannot obtain a foothold in loose soil. Under these conditions it is difficult for a fine pasture plant to establish itself firmly, while coarser growing and more objectionable plants such as Yorkshire fog grass will prevail. It is not unusual to see the fine-leaved perennial rye-grass plants firmly established along a beaten track or around a gate. The explanation is probably that the heavier traffic in these parts has consolidated the surface soil more so than in other parts of the field to the advantage of this finer and more desirable plant.

Rainfall and Soil.

With the land well cultivated and free from weeds and weed seeds, it becomes necessary to decide upon the pasture species to be sown. This selection depends on three main considerations. Firstly, the rainfall, in the light of its amount and evenness of distribution

A permanent pasture showing predominance of perennial rye grass.

throughout the year, both of which factors have a determining influence upon the efficiency of the rainfall for different species of winter and summer-growing grasses and clovers. A mixture of both summer and winter growers requires an even rainfall throughout the year, whereas a winter rainfall will support only winter and spring growers, and a summer rainfall makes the introduction of summer-growing species possible.

Secondly, consideration of the soil type will be necessary to determine its suitability to support particular species. A heavy soil is necessary for the best development of white clover and perennial rye-grass, while a lighter soil is more suited to such a plant as subterranean clover.

Thirdly, the pasture requirements of the farm need consideration. If winter feed is required, then winter-growing species such as the rye-grasses—phalaris tuberosa and subterranean clover—must be used. On the other hand, summer growers may be needed, in which case special species such as cocksfoot, paspalum, and strawberry clover should be selected. For all-the-year-round grazing, a more balanced mixture, consisting of both summer and winter growers, such as a combination of rye-grass, cocksfoot, white clover, and strawberry clover, must be selected, carefully mixed and sown.

Select Suitable Strains.

A further point worthy of the closest consideration is that of the strain or "variety" of pasture plants used. Many failures in the establishment of permanent pastures in the past have been due to the use of unsuitable strains of rye-grass, cocksfoot, and white clover. When laying down pastures in the future special thought should be given to the choice and selection of reliable and trustworthy strains, particularly of these species.

In the case of rye-grass, it has been believed that any New Zealand seed is reliable. But trials conducted by the Agrostology Branch

A permanent pasture with white clover predominant.

of the Department of Agriculture have shown that certified seed is the only reliable importation from this source; the bulk consisting mainly of short-lived types which largely disappear and give place to weeds in the second and third year of the life of the pasture. Victorian Western District seed harvested from old pasture gives a satisfactory and persistent stand of perennial rye-grass. But it

is necessary to buy with care and discrimination from a reliable source—no Government certified Victorian seed being on the market at present. Victorian cocksfoot seed, especially that harvested from volunteer or old pastures will give rise to plants of a leafy productive type equal to the best New Zealand cocksfoot, and definitely superior to European importations.

The work on white clover has not proceeded far enough to enable a definite statement to be made as to the most reliable strains. No seed of this plant is harvested in Victoria, and of the importations New Zealand seed may be regarded as the most reliable and satisfactory under our conditions, and to be preferred to other lines.

Varying climatic and soil conditions make recommendation of definite pasture mixtures a delicate problem, so that farmers are compelled to study their own conditions and requirements before adopting any particular mixture. However, a few basal mixtures on which slight alterations only may be necessary are suggested:—

Gippsland and Beech Forest.

Alluvial Flats—

	Lb. per Acre.
Perennial rye-grass	20
Cocksfoot	5
White clover	2

Hill Country—

	Lb. per Acre.
Cocksfoot	10–15
Perennial rye-grass (according to amount of cocksfoot sown)	15–10
White clover	1
Subterranean clover	1

On light hill country cocksfoot and subteranean clover alone will give a desirable pasture, though it is necessary to include Italian rye-grass to give winter growth and cover, and to exclude weeds in the first year. A suitable mixture is—

	Lb. per Acre.
Cocksfoot	15–20
Subterranean clover	2
Italian rye-grass	6

Western District.

	Lb. per Acre.
Perennial rye-grass	20
Subterranean clover	2

On heavy soils the subterranean clover may be omitted, and white and strawberry clovers included. As little as 2 oz. of strawberry clover seed per acre usually is sufficient to introduce this plant and permit of its ultimate establishment.

A mixture worthy of trial on a small scale on medium hill country in Gippsland and the Western District is—

	Lb. per Acre.
Phalaris tuberosa	3
Cocksfoot	8
Perennial rye-grass	10
Subterranean clover	2

This mixture, however, is more expensive than others recommended.

Perennial rye-grass is eminently suited to heavy land with a moderate rainfall. It produces the bulk of its herbage during the spring and autumn months; makes fair winter growth, and is capable of withstanding heavy grazing. *Cocksfoot,* on the other hand, grows well in medium and light hill country with a fair summer rainfall. It makes poor winter growth, but gives good feed during the remainder of the year, providing seasonal conditions are normal. Under light soil conditions cocksfoot should be the dominant pasture grass with perennial rye-grass sub-dominant, the position of these two pasture plants being reversed on the heavier soils.

Phalaris tuberosa, which is a perennial plant, makes very good growth in winter as well as in the autumn and spring, and is capable of remaining dormant under very dry summer conditions. It is suited to medium class soils with a moderate rainfall. With light grazing it becomes tussocky and objectionable in a pasture, but under heavy stocking produces a plentiful amount of palatable leaf.

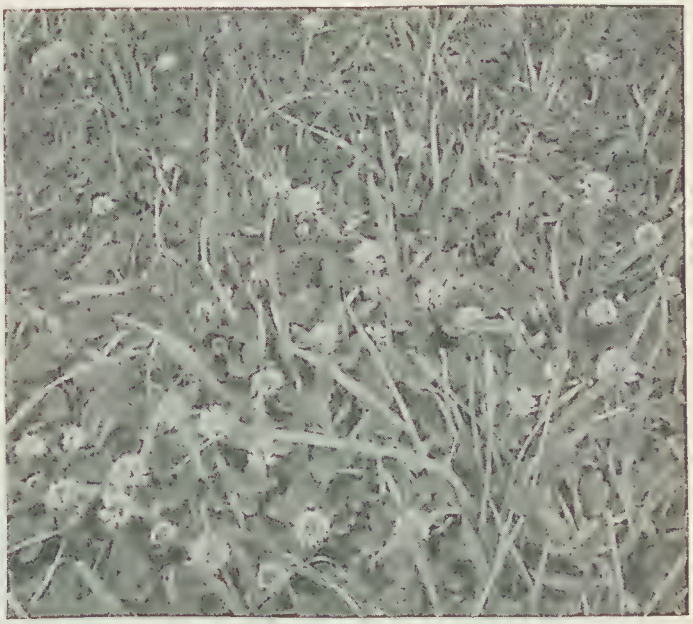
White clover should be the companion plant to perennial rye-grass, especially under conditions of good rainfall. It does not appear to have the same range of adaptation to moderately dry conditions as perennial rye-grass. Under such conditions subterranean clover apparently becomes a more suitable complement. Under favorable conditions, white clover grows throughout the year, making its principal growth during autumn and spring.

Strawberry clover is a perennial well suited to heavy black soils, and makes its best growth in the summer and autumn months. A very light sowing is sufficient to permit of its ultimate establishment and to replace white clover should this species tend to disappear.

Strawberry clover appears capable not only of withstanding a certain amount of flooding, but also of growing under rather drier conditions than white clover. Apparently, however, it is more restricted as to the soil type to which it is adapted.

Subterranean clover is a winter and spring grower which withstands hard grazing on light to medium soils with a moderately light rainfall. Although an annual plant, its abundant setting of seed ensures its regeneration from year to year, especially under phosphatic top-dressing.

Once species and strain have been decided upon, the next step is to obtain seed that is clean, true to type, and highly fertile. This is, admittedly, a difficult task which, however, can be overcome to a certain extent by purchasing on sample from a reliable source.



A good permanent pasture mixture with perennial rye-grass, cocksfoot, and white clover predominating.

Time of Sowing.

With land and seed ready, the question of the correct time to sow down assumes importance. This depends largely on seasonal conditions, but as a general guide it may be pointed out that sowings after the first autumn rains meet with success unless it happens that a prolonged dry spell follows. Mid or late autumn sowings have given the best results in the Western District, while in central and south Gippsland and Beech Forest sowing in either early or mid-autumn not only has proved most satisfactory, but appears to be highly desirable to permit of seedling establishment before the cold winter sets in.

In the higher rainfall areas spring sowings may be undertaken in a normal season without fear. In these areas the rain usually is sufficient to carry the plant on throughout the spring and summer months.

The method of sowing becomes a factor in the successful laying down and subsequent establishment of permanent pastures. In every case the small seed of grasses and clovers should be sown on the surface, and covered subsequently either by light harrowing or rolling or by both. The importance of surface sowing can be understood when it is realized that the food supply within the tiny seed has to suffice until the first green shoots are through the ground and able to perform their function in the life of the plant. If buried at all deeply the seeds may not germinate, or if they do the tender shoot may fail to reach the surface. Here, too, the finer grazing plants will fail and allow larger seeded and coarser growing species to obtain the upper hand. Shallow sowing is therefore an important phase of successful pasture establishment.

At the time of sowing, or soon after, it is advisable to top-dress with artificial fertilizer. This application of readily available plant food promotes quicker and stronger growth, and so gives the plant a good start and enables it to compete more successfully with the strong growing annual weeds.

It is not advisable to allow the mixed seed and superphosphate to stand longer than an hour or two before sowing, because of the tendency of the acid of the fertilizer to reduce the germinating capacity of the seed. The artificial manure used and its rate of application per acre will depend largely on local experience for the particular soil type in question, but superphosphate at the rate of 1 cwt. per acre is a safe suggestion for the majority of the country south of the Divide. The use of nitrogenous fertilizer to promote winter growth is at present the subject of

(*Continued on page* 206.)

Concrete Fence Posts

Materials and Methods

By W. J. B. McDonald, B.Agr.Sc., Assistant Inspector of Agriculture.

A Permanent Fence.

RECENT events of an extremely diversified nature cannot fail to have caused many farmers to contemplate seriously the necessity for further expenditure in fencing. Those land-owners whose fences have suffered through grass or bush fires must shortly repair the damage, while others in the high rainfall and irrigated districts are finding greater subdivision of their holdings necessary to enable them to change gradually to the modern system of pasture management.

In every district of this State miles of fencing are in urgent need of replacement or extensive repair, and it is fairly safe to assume that practically every farmer is vitally interested in the economics of fencing.

Fences are more or less permanent structures representing considerable labour and capital both in first cost and, subsequently, in maintenance. The location and type of fence adopted are matters that warrant exhaustive investigation before committing one-self to the construction of a costly improvement that, unless built according to a well-defined scheme, may eventually prove to be in quite the wrong place, and, furthermore, a constant drain on the capital and labour resources of the farm. It is not proposed at this stage to discuss the manner of subdivision of a holding, but rather to draw attention to the possibilities of a more permanent style of fencing than that provided by the use of wooden posts.

Most farmers probably are vaguely aware of the possibilities afforded by the use of concrete fence posts, but relatively few have realized the significance of that possibility in relation to their own holdings. Once this rather vague and questioning appreciation of concrete has been overcome one can confidently predict a considerable increase in its use. In the heavily-timbered areas of Victoria—where oftentimes the cost of a fence post can be expressed solely as the labour in cutting and shaping it—on the score of first cost alone, concrete fence posts cannot hope to compete successfully with timber as the basis

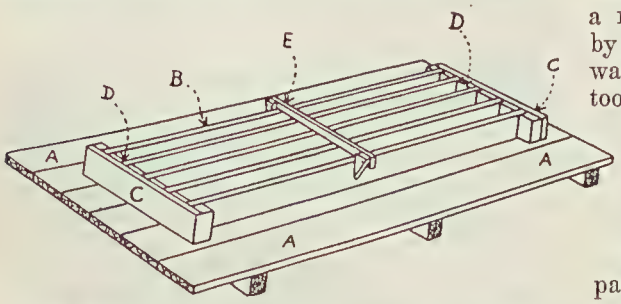
Concrete fence posts at Longerenong Agricultural College.

of a fence line; but in those parts of the State where the provision even of firewood is becoming a serious problem, the use of concrete fence posts must be seriously considered, as they possess many advantages which more than offset a possible slight disadvantage in first cost.

Any general purpose fence should fulfil the following conditions:—

(1) It should be capable of meeting any demands liable to be made upon it;
(2) It should be reasonable in first cost;
(3) Maintenance costs should be low;
(4) It should be fire resistant; and
(5) It should be white ant resistant.

Wooden posts are universally regarded as the standard basis for a fence. Except in rare instances where required for ornamental or special purposes, iron fence posts are obtainable only at a prohibitive cost, and owing to their tendency to corrosion require frequent painting. This means a considerable cost of upkeep. Wooden posts do not satisfy the 3rd, 4th, and 5th conditions above. There is one material left, which satisfies either wholly or in great part all the conditions laid down above, and that is reinforced concrete.



Mould for four untapered concrete fence posts.

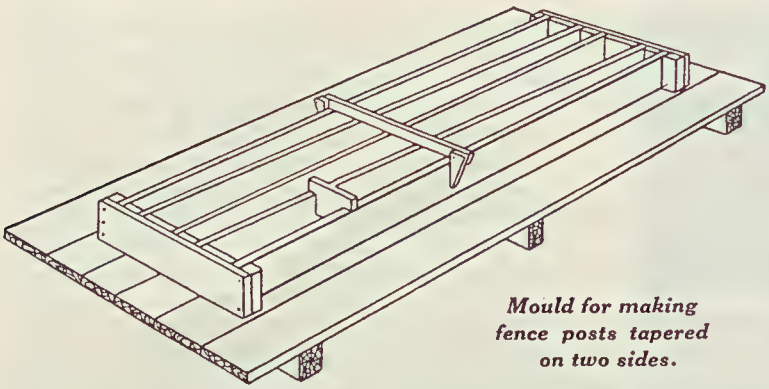
"A" is the baseboard, "B" indicates the wooden boards of either 1 or 1½ inches in thickness required to form the sides of the posts, "C" indicates the end pieces, to which are attached the "lugs" indicated by the letter "D," leaving slots into which the boards "B" fit. "E" is the brace to prevent the sides from bulging, of which one or more may be used.

The present era with considerable justification often has been termed the age of concrete. Unfortunately in the past timber has been woefully wasted and is no longer easily procurable. Wage rates are relatively high, making maintenance work correspondingly costly. As a result, it is becoming increasingly necessary to consider the ultimate rather than the initial cost of structural work. Looked at from this angle, the economy of concrete work becomes more apparent as its strength increases with age, and ordinary destructive agencies have no effect on its stability. Maintenance costs therefore are at an absolute minimum.

A corner of the horse-yards at Longerenong.

The recent disastrous fires in various districts of the State afford a powerful argument in favour of fire-proof fencing. Even in ordinary burning off by controlled fires, quite a number of posts are charred and injured by vagrant streaks of flame that escape the watchful eye of the burner. It would be, too, a great advantage were the fire allowed to clean up the rubbish and vermin that find a more or less permanent breeding ground in the cover that invariably characterizes a fence line.

White ants cause a great deal of damage, particularly in the northern parts of the State, unless the posts have been chosen with meticulous care and necessarily at a correspondingly high cost. Concrete, of course, is quite immune to the ravages of these and similar pests. It must be fairly obvious, even to the prejudiced, that the maintenance cost of concrete work is almost negligible.



Mould for making fence posts tapered on two sides.

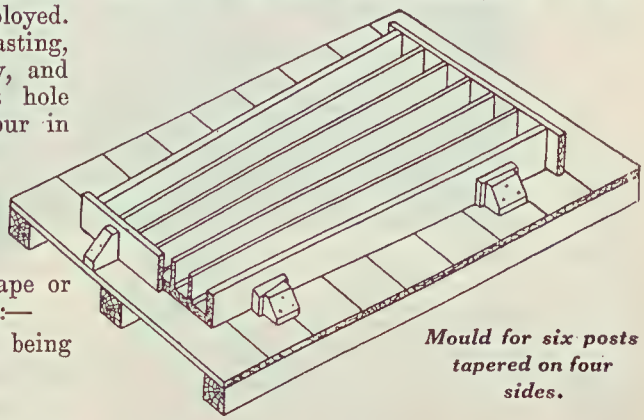
The first cost in the making of reinforced concrete fence posts varies with the availability of the ingredients, but under most conditions is reasonable. They can be made on the spot by local unskilled labour or by farm labour which, owing to wet weather or normally slack periods in farm routine, would otherwise be idle or less profitably employed. Concrete posts are practically everlasting, becoming stronger as the years pass by, and in soils adapted to the use of a post hole borer their use saves considerable labour in the actual erection of the fence, as the relatively small cross section of the concrete post will fit into the hole made by this implement, whereas the ordinary wooden post will not.

Concrete posts can be cast in any shape or size. The simplest types are as follow:—

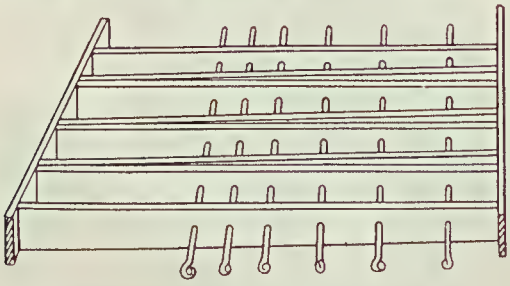
(1) Square in section without being tapered.
(2) Tapered on two sides.
(3) Tapered on four sides.

Tapered posts are lighter in weight, and consequently more economical than square ones, although their strength is not appreciably diminished. They are very pleasing to the eye and, once the moulds have been made, are no more difficult to manufacture than other styles. Concrete when first manufactured is more or less fluid in character, and is brought to the desired shape by allowing it to set in moulds of that shape and size.

The mould for a single post may be described as a long bottomless box or trough which is placed on a flat board when concreting. As, however, it usually is required to make more than one post, moulds are generally arranged in sets, a convenient size providing for the making of four posts simultaneously. If the posts are to be tapered on two sides only, it is possible to arrange the sets so that the top and butt of each post alternate. Where, however, the four sides are tapered this arrangement is not possible and all the butts are kept at the one end.

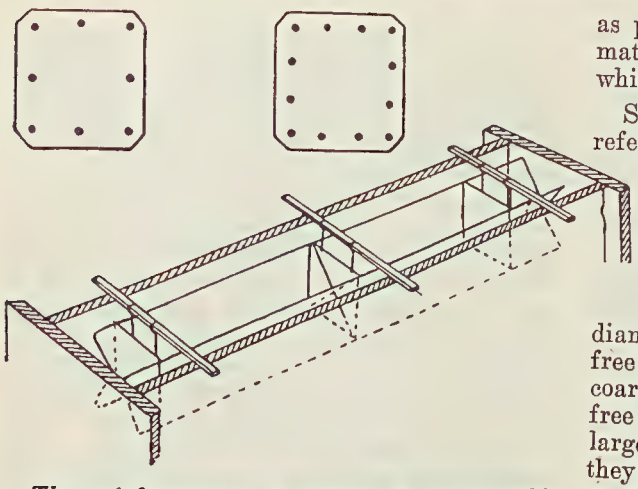


Mould for six posts tapered on four sides.



Mould with iron rods in position for casting holes.

The construction of the moulds is illustrated in the accompanying sketches. The length, width and depth of the spaces correspond to the dimensions of the post to be moulded. The wooden boards required to form the sides of the mould should be 1 or 1½ inches in thickness. The component parts of the mould may be held together by hooks and eyes or by wedges placed on the base board, but whatever the means adopted they should be such that the parts of the mould are easily removable when the concrete has set and hardened. Where moulds are to be used frequently, the edges should be protected from injury during tamping and trowelling by dressing with strips of hoop iron. Posts present a neater finish, and



The reinforcement suspended in the mould. Above: Transverse section of two corner posts showing position of reinforcement rods.

are less liable to injure the stock if the corners are chamfered. This can be obtained by placing triangular shaped strips of wood in the bottom corners of the mould and bevelling the top edges of the concrete with a trowel.

Any fence post may be called upon to withstand a considerable force applied from any direction. To ensure that concrete fence posts satisfy this condition they should be reinforced with steel rods of $\frac{1}{4}$-inch section, which should be set into the four corners of the mould at about $\frac{3}{4}$ inch from the outside surfaces. The ends of the rods should be bent over at right angles and turned inwards, the strength and convenience of placing the reinforcements being considerably increased by lacing together by stout wire to form a framework which can be placed or suspended in the mould in the fashion illustrated. Where heavy posts, such as corner posts, are to be constructed stouter reinforcement of $\frac{3}{8}$-inch section should be used. The reinforcement should be placed in position before the concrete is made.

Materials.

Concrete is a mixture of cement, sand, pebbles, or broken stone and water in certain definite proportions, according to the purpose for which it is required. All concrete should be as dense as possible, consequently cement, sand, and stone are so proportioned that the spaces left between them are as small as possible, and all the surfaces of the mixed materials are coated with a layer of cement which on hardening binds them together.

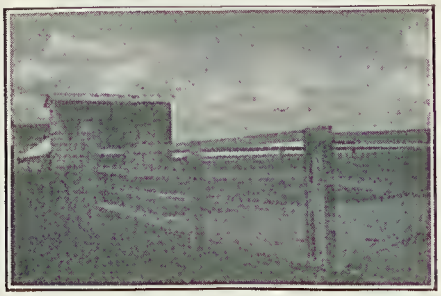
Sand, pebbles, and broken stone are usually referred to as aggregate, sand and small pebbles or rock fragment being spoken of as fine aggregate, while all material which will not pass through a $\frac{1}{4}$-inch mesh is regarded as coarse aggregate. For fence posts the coarse aggregate should not be more than half an inch diameter. Sand should be clean, hard, and free from dust, clay, or vegetable matter. The coarser aggregate should be clean and hard and free from flaky or elongated particles. For large posts bigger stones could be used, but they must be well graded so as to have a correct proportion of large and small stones.

Good quality concrete is required for a satisfactory fence post. A 1:2:3 mixture combines strength with economy. A "1 : 2 : 3 mixture" means 1 cubic foot of cement to 2 cubic feet of sand and 3 cubic feet of pebbles or crushed stone, the ingredients always being referred to in that order.

Concrete mixing must be carefully and thoroughly carried out, the amount of each ingredient being accurately measured on to the mixing board. A convenient measure can be made by constructing a bottomless box, the internal measurements of which are 12 in. x 12 in. x 12 in. This box can be placed on the mixing board and filled with the desired ingredient, the box frame then being lifted off, leaving 1 cubic foot of material on the board.

Completed posts at Longerenong.

Concrete may be mixed either by hand or machine, more thorough mixing usually resulting from the use of the machine. However, perfectly good concrete can be made by hand, provided the proper care is taken. Mixing should continue until every particle of the ingredients is covered with a layer of cement. Hand mixing should be carried out on a specially constructed watertight platform, preferably constructed of 1½-inch tongued and grooved boards adequately braced to give a rigid platform 7 feet by 12 feet. Along two sides and one end of the platform a strip of wood should project 2 inches above its surface to prevent materials from being washed or shovelled off during the mixing.



Concrete fence posts round the cow yards at Longerenong.

The usual method of hand mixing concrete is as follows:—The correct amount of sand is measured and spread evenly over the platform. Over this the required amount of cement is evenly distributed The two ingredients are then thoroughly mixed by turning with square mouthed shovels until the mass presents a uniform colour free from streaks of brown or grey. The required amount of coarse aggregate is then spread over the sand and cement, and the turning repeated until another uniform mixture is obtained. At least, three turnings will be necessary.

When satisfied as to the uniformity of the mixture, a depression is made in the centre of the pile and water added slowly. The mixture is again turned until the cement, sand, pebbles, and water have combined to form a uniform pasty mass of a jelly-like consistency. Concrete should not be wet enough to flow easily or assume a soupy consistency, as too much water greatly reduces the strength of the mixture. The water added should be clean and free from any acid or alkali.

Before using the moulds should be lightly rubbed with oil, grease, or soft soap to prevent the concrete adhering to the wood and iron. With the moulds ready and the reinforcement already in position, the concrete should be placed in the moulds as soon as possible after mixing, since it begins to set in about 20 minutes, after which period it rapidly loses its value unless already in position. *Concrete must be set in the moulds immediately it is completely mixed.* As the concrete is being placed, it should be thoroughly tamped in with a rammer to set it thoroughly around the reinforcement and to properly fill all the spaces within the mould. Any pieces of coarse stone should be forced back from the side of the moulds and the mortar forced in. This makes a good, dense concrete with a smooth even surface. With the moulds almost full, the supports carrying the reinforcement are removed and the upper surface smoothed off with a wooden trowel or float. If a steel trowel be used, one surface of the post will be possessed of a gloss which rather contrasts with the remaining three sides. If so desired the component parts of the mould may be removed after 24 hours, but it is better to leave the post in the mould for two or three days. After removal the moulds should be thoroughly cleaned in preparation for their next use.

Moisture is necessary to the proper hardening or curing of concrete, so to prevent drying out it is necessary to protect the newly formed posts by covering with hessian or bags which must be kept moist for a period of eight to ten days. The posts may be removed from the base board after four to five days, but are better left for the longer period indicated above. Even, then, considerable care in handling is required as the posts do not become properly hard for about two months, and should not be erected until they are at least three months' old. If possible, the posts can be profitably immersed in water during this period, or failing such a facility bedded down in wet sand, sheltered from the sun and sprayed to maintain a moist condition.

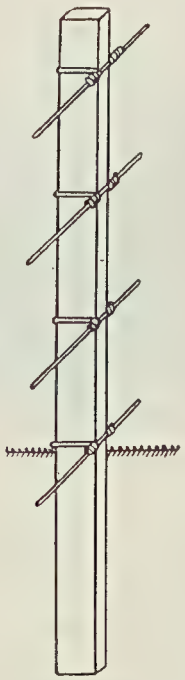
Posts may be made in any desired size, but a convenient size for a fence line post is 6 feet long by 6 inches x 5 inches on the bottom tapering to 6 inches x 3 inches at the top. Using a 1:2:3 mixture a barrel of cement which measures one-sixth cubic yard will make 23 or 24 posts of this size.

In setting a post of rectangular cross section in the fence line, the long face of the post should be set at right angles to the direction of the fence, as it is from this direction that the greatest stress is likely to come.

Corner posts or gate posts which are subject to a very heavy load must be made much stronger than the ordinary line post, consequently they are made much heavier and larger with correspondingly heavy reinforcement. Three or four $\frac{3}{8}$-in or $\frac{1}{2}$-in. steel rods should be placed about 1 inch from the surface on each face of these posts. When making corner or gate posts provision must be made for embedding the required bolts or fittings. The most convenient method consists of placing greased rods through the forms, and withdrawing them some hours after placing the concrete. The rods should be slightly larger than the size of bolt the holes are required to carry. Ordinary line posts can also be treated in this fashion to make holes to carry the fencing wire.

Straining posts can be made in a similar fashion to line posts, but provision for taking the end of a brace or strut must be made. The simplest way of so doing is to make an indent not more than 1 inch deep in the concrete at a point not more than two-thirds of the distance from ground level to the top of the post. Struts to take the strain imposed by tightening the wires should be made in the same way as posts and should be 5 inches or 6 in. x 4 in. cross section, with $\frac{1}{4}$-in. or $\frac{3}{8}$-in. iron rod reinforcement at each corner.

In erecting the fence the operator has the choice of several methods of attaching the wire. The most satisfactory, of course, is that in which the holes have been cast in the concrete and the wires threaded through the post. Long galvanized iron staples with the ends bent out at right angles can be set in the newly-placed concrete, and the wire threaded through these. A third method consists of holding the wire in place by fastening to a binding wire wrapped tightly round three sides of the post, the two ends being twisted round the fence wire. For barbed wire fencing this method probably is the best. Concrete fence posts have been used extensively at the Dookie and Longerenong Agricultural Colleges where the advantages derived from their use are such as to make their manufacture a regular part of farm routine. At Longerenong, where sand is easily obtainable and screenings or gravel are not, the mixture used consists of one part of cement to three and half of sand (1 : $3\frac{1}{2}$) with four pieces of No. 6 wire as reinforcement, each placed 1 inch from the corner. The post is 5 ft. 4 in. over all, giving 20 inches below ground level and 3 ft. 8 in. above. Six holes are cast to carry the normal wire, and a groove and small hole at the top to carry the barb and a binding wire respectively. The posts taper from $4\frac{1}{2}$ inches x $5\frac{1}{4}$ inches at the bottom to $3\frac{1}{2}$ inches x $4\frac{1}{4}$ inches at the top. The cost of this particular post is 1s. $6\frac{1}{2}$d. From personal observation these posts are known to give every satisfaction.



One method of attaching the wires.

Apart from their utilitarian aspect, concrete posts add greatly to the appearance of a property, thus considerably enhancing its resale value.

The quantities of materials required for line and corner posts are shown in the accompanying tables, which, with the diagrams accompanying this article are reproduced by courtesy of the Australian Cement Manufacturers' Association.

Table No. 1.—Quantities of Materials for Concrete Line Posts.

Dimensions of Post.			Weight of Post, Pounds.	Amount of Reinforcement in Each Post.	Materials. For Six Posts. 1 Cement: 2 Sand: 3 Gravel.				Total Imperial Gallons of Mixing Water Required for Each Six Post Batch of Concrete.		
Length.	Top.	Bottom.			Paper Bags 94 lb.	Jute Bags 125 lb.	Cubic Feet Sand.	Cubic Feet Gravel.	Dry Sand and Coarse Aggregate.	Moist Sand and Coarse Aggregate.	Wet Sand and Coarse Aggregate.
7′ 0″	3″ x 4″	5″ x 4″	101	Four ¼″ Round or Square Rods	1⅛	¾	2⅜	3½	5	4	3⅝
7′ 6″	3″ x 4″	5″ x 4″	120		1¼	⅞	2½	3⅞	5⅝	4⅜	4
8′ 0″	3″ x 4″	5″ x 4″	130		1⅜	1	2¾	4⅛	6¼	4⅞	4½
7′ 0″	4″ x 4″	6″ x 4″	140		1½	1⅛	3	4½	6¾	5¼	4⅞
7′ 6″	4″ x 4″	6″ x 4″	150		1⅝	1¼	3¼	4¾	7⅜	5⅝	5¼
8′ 0″	4″ x 4″	6″ x 4″	160		1¾	1⅜	3⅜	5⅛	7⅞	6⅛	5⅝

Note.—Use the numerals under columns marked "paper bags" or "jute bags" according to which bag is being used.

Table No. 2.—Quantities of Materials for Gate and Corner Posts.

Dimensions.		Approximate Weight of Posts in Pounds.	Amount of Reinforcement in Each Post.	Materials. For One Post. 1 Cement: 2 Sand: 3 Gravel.				Total Imperial Gallons of Mixing Water Required for Each One Post Batch of Concrete.		
Length.	Size.			Paper Bags.	Jute Bags.	Cubic Feet Sand.	Cubic Feet Gravel.	Dry Sand and Coarse Aggregate.	Moist Sand and Coarse Aggregate.	Wet Sand and Coarse Aggregate.
8′ 0″	8″ x 8″	525	Four ½″ Round Rods	⅞	⅝	1⅞	2¾	4	3	2⅞
8′ 6″	8″ x 8″	560		1	¾	2	2⅞	4½	3½	3¼
9′ 0″	8″ x 8″	595		1	¾	2	3	4½	3½	3¼
8′ 0″	10″ x 10″	800		1½	1⅛	2⅞	4⅜	6¾	5¼	4⅞
8′ 6″	10″ x 10″	850		1½	1⅛	3	4½	6¾	5¼	4⅞
9′ 0″	10″ x 10″	900		1⅝	1¼	3¼	4⅞	7⅜	5⅝	5¼
8′ 0″	12″ x 12″	1,150		2	1½	4⅛	6⅛	9	7	6½
8′ 6″	12″ x 12″	1,225		2⅛	1⅝	4⅜	6½	9½	7½	7
9′ 0″	12″ x 12″	1,300		2⅜	1¾	4⅝	6⅞	10⅝	8⅜	7¾

Note.—Use the numerals under columns marked "paper bags" or "jute bags" according to which bag is being used.

Tobacco Growing

IX.—Production Costs

By W. J. B. McDonald, B.Agr.Sc., Assistant Inspector of Agriculture; and G. E. Coghlan, Tobacco Expert.

The first Article of this Series, which appeared in the August issue of the Journal, dealt with the soil and climatic conditions most suitable for Tobacco growing and the preparation of Seed beds. Subsequent Articles in the September, October, November, December, January, February and March issues describe the methods of transplanting the seedlings, the Work involved in the care of crops, the construction of flue curing barns, and in the selection of seed, harvesting, and curing, and methods of marketing the leaf. This article concludes the series.

SINCE 1929 there has been a considerable annual increase in the area sown to tobacco in Australia, particularly in Victoria. (See Table I.). This increase has been obtained partly by the expansion of areas planted by long established growers, but, in greater part, by the advent of many new growers to the industry. Inevitably some of the latter, through location in unsuitable environments or through the unsuitability of the individual, will be forced out of the industry, but their seems to be little doubt that for some time at least their places will be more than filled in the ensuing season by an eager throng of still newer growers. As a guide to those contemplating an investment of capital or energy in the growth of tobacco, the following notes as to the general trend of production and some of the unavoidable costs involved are furnished.

Transporting leaf to the curing barn.

In Table II. an attempt has been made to show the effect of tariff changes on the acreage planted to tobacco. It will be observed that under a tariff rate of 2s. per lb. the industry remained at a fairly constant level, the variations in acreage being relatively small. The increase of the import duty in 1929 and July, 1930, coincides with a sharp rise in acreage and the increase to 5s. 2d. per lb. in December, 1930, undoubtedly was the main factor responsible for the enormous development of tobacco growing in the following year. Perhaps the next most important factor was the fact of economic depression on prices of primary products and the consequent failure of almost all other agricultural pursuits to return farm revenue commensurate with the amount of money invested and labour involved.

This increase in the acreage planted to tobacco is not confined to Victoria, both N.S. Wales and Queensland exhibiting proportional increases (Table I.). The expansion of tobacco growing within Australia has been coincident with an increase in the demand for the local product, and a definite decrease in the total amount of tobacco consumed (see Table III.), resulting in a decrease in the amount of tobacco imported.

The vital question affecting the Australian grower is just what proportion of the imported leaf can be replaced by locally grown tobacco, and how rapidly this very desirable change can be effected. The bulk of the tobacco

smoked by the Australian consumer is a type conforming to that known as Bright Flue-cured Virginian (see Table IV.) which in 1929 composed 95.8 % of our total leaf imports, the remaining 4.2% by weight conforming to the type known as Dark Virginian. It will be seen also that the amount of dark tobacco imported in 1923, (27.4 % of the total) declined in a period of six years to an amount equal to only 4.2 % of the total. This emphasizes the oft repeated statement that the Australian consumer, irrespective of the form in which the weed is consumed, demands a light colored tobacco.

It becomes increasingly obvious then, that the rapidity with which the local grower can capture the Australian market will depend largely on the rapidity with which the bulk of his product is brought to the stage in which it is comparable in colour, texture, and aromatic quality with the imported product. It will depend also on the time required by the consumer to adjust his palate to any essential difference in flavour between the local and imported leaf.

The solution of the first of the problems confronting the grower is essentially in his own hands, and with regard to the second it is confidently expected that in course of time the necessary adjustment of taste of consumers will follow normally. Attention to principals outlined in previous articles in this series should aid the grower in producing the article required.

Some idea of the proportion of the Australian market which the local grower may capture ultimately, though not immediately, may be obtained perhaps from a study of American figures. Table V. shows that for the years 1925 to 1929 the average quantity of American grown leaf manufactured annually in U.S.A. equals 837,014,000 lb., while the average quantity of leaf imported over the same period amounts to 105,350,000 lb. It is thus seen that even in America where tobacco growing has been practised over a wide range of soils and climates for hundreds of years, a considerable importation of foreign tobacco is necessary if the quality of their blends is to be maintained. The amount of leaf imported approximates 12 per cent of the total amount put into manufacture.

On this basis, Australia, with an equally wide range of soils and climates, may ultimately produce between 80 per cent and 90 per cent of her total requirements, but it is anticipated

TABLE I.—SHOWING ACREAGE AND PRODUCTION OF TOBACCO IN VICTORIA AND AUSTRALIA FOR THE YEARS 1920–21 TO 1929–30.

Year.	Victoria.			Australia.		
	Yield.	Acreage.	Average Yield.	Yield.	Acreage.	Average Yield.
	lb.		lb.	lb.		lb.
1920–21 ..	101,696	95	1,070 +	1,093,344	1,345	812 +
1921–22 ..	418,420	604	693 +	1,504,496	1,967	765 +
1922–23 ..	464,912	890	522 +	3,665,648	3,727	983 +
1923–24 ..	130,480	1,047	124 —	1,376,592	2,783	495 —
1924–25 ..	358,288	1,228	292 —	1,014,608	2,149	472 +
1925–26 ..	881,552	1,179	748 +	2,314,816	2,759	849 +
1926–27 ..	386,848	1,154	335 —	1,218,336	2,192	556 —
1927–28 ..	1,014,160	1,176	862 +	1,808,016	2,133	848 —
1928–29 ..	1,050,000	1,317	800 +	1,838,592	2,238	821 +
1929–30 ..	1,093,120	1,822	600 +	1,523,984	2,470	617 —
1930–31 ..	1,222,668 (approx.) (540 returns)	2,650 (approx.)	461 + (approx.)	1,750,000 (approx.)	3,500 (approx.)	..
1931–32 ..	Not available	6,000 (approx.)	Not available	Not available	13,000 (approx.)	Not available

Average Victorian yield for ten years (1920–21 to 1929–30) = 561 lb.

Extremes—
1,070 lb./ac. in 1920–21.
124 lb./ac. in 1923–24.

Average for New South Wales = 950 lb./ac.

Average Australian yield for same period = 780 lb./ac.

that, owing to reasons already enumerated, it will be some years before this stage is reached. After careful consideration of various aspects of the question, it is the opinion of the writers that there is a possibility of the Australian leaf replacing the imported leaf to the extent of approximately 12,000,000 lb. in the near future, but that the rate of replacement cannot exceed approximately 4,000,000 lb. per annum without dangerously affecting the market.

TABLE II.—INFLUENCE OF TARIFF ON TOBACCO ACREAGE.

—	Tariff Incidence.	Influency Crop for—	Acreage.
1921	Tariff increased to 2s.	1922–23	890
		1923–24	1047
		1924–25	1228
		1925–26	1179
		1926–27	1154
		1927–28	1176
		1928–29	1317
21.9.29	Tariff increased to 3s.	1929–30	1822
1.7.30	Tariff increased to 3s. 6d.	1930–31	2650
3.12.30	Tariff increased to 5s. 2d.	1931–32	6000 (estimated)

From Table I. it will be seen that in Australia the average production of tobacco per acre is 780 lb. The bulk of this cannot be classed as bright tobacco, and this figure is considerably in excess of the yield of that class of leaf that could be expected from off soils naturally adapted to its growth. Assuming that an average yield of 500 lb. of bright flue-cured leaf per acre could be obtained, 24,000 acres would produce 12,000,000 lb. of leaf of the requiste type. Without considering any possible outlet provided by an export market, it is believed that this area would provide, for several years, all the Australian leaf that could be absorbed by the local market.

Table VI. gives some indication of the rapidity with which the tobacco-growing industry has expanded in various parts of the Empire. The most rapid increase occurred in Southern Rhodesia, where, in a period of eight years, production jumped from 620,000 lb. to 19,000,000 lb. per annum. Provided sufficient incentive were offered, a similar rate of increase is well within the power of Australian growers.

In some quarters, it is still believed that an almost unlimited expansion in the acreage sown to tobacco can be effected without glutting the home market. Although such a point has not yet been reached, a careful study of the tables herewith will show that this state could be reached in a relatively short time. Such a glut actually did occur towards the end of the last century.

TABLE III.—SHOWING AMOUNT AND VALUES OF TOBACCO IMPORTATIONS TO THE COMMONWEALTH, 1926–27 TO 1930–31.

Year.	—	Manufactured Tobacco.	Unmanufactured Tobacco (Unstemmed Leaf).	Cigars.	Cigarettes.	Snuff.	Total.
1926–27	lb.	1,273,873	22,140,918	121,779	744,571	4,315	24,285,456
	£	176,046	2,018,295	115,360	393,386	1,667	2,704,754
1927–28	lb.	1,187,202	23,682,640	128,713	946,350	3,442	25,048,347
	£	171,800	2,168,402	138,591	480,798	1,029	2,960,620
1928–29	lb.	1,069,532	21,137,672	108,692	1,019,514	3,439	23,338,849
	£	159,607	1,905,194	111,670	516,606	1,288	2,694,365
1929–30	lb.	881,056	20,279,533	87,443	879,112	3,282	22,130,426
	£	138,847	1,767,942	96,141	417,527	1,176	2,421,633
1930–31	lb.	330,545	22,393,045	18,218	189,617	2,327	22,933,752
	£	44,857	1,413,374	26,618	79,919	868	1,565,636
Percentage Decrease from 1929–30 to 1930–31 in Value of Imports ..		67%	20%	73%	81%	26%	

Possible Income from Tobacco.

The fabulously large incomes which frequently are attributed to the tobacco-grower are mostly figments of fancy. While it is true that occasional growers have obtained very considerable gross returns from their tobacco crops in a particular season, it must be remembered that their expenses are correspondingly heavy, and are not confined to the one year, but represent an annual outlay which in many seasons is not covered by their returns. The risks attached to tobacco-growing are even greater than are those usually associated with agricultural production, and the proportion of good years to bad is considered by many old growers to be in the ratio of one to three.

A Stick of Leaf from the Kiln.

In considering the profits possible from tobacco-growing, individual results must be discarded in favour of average returns obtained by a number of growers over a period of several years. Unfortunately, exact statistical data covering gross receipts and expenditure in the production of tobacco in Victoria are not available, but approximations based on the experiences of a number of sound growers, and on the average yield over the whole State, are appended.

TABLE IV.—AUSTRALIAN IMPORTS OF BRIGHT FLUE-CURED AND DARK VIRGINIA, 1923 TO 1929.

—	Bright Flue-cured Imported.	Dark Virginia.	Percentage Weight of Bright.	Percentage Weight of Dark.
1923	14,349,525	3,940,425	72·6	27·4
1924	17,092,849	3,143,703	81·6	18·4
1925	19,673,895	2,912,001	85·2	14·8
1926	20,246,676	2,479,931	88·1	11·9
1927	17,246,676	2,335,738	86·5	13·5
1928	20,049,992	779,584	96·1	3·9
1929	18,488,091	775,183	95·8	4·2

The cost of producing one acre of tobacco will naturally vary according to the particular district and soil type being exploited, but various witnesses appearing before the Select Committee inquiring into the Australian tobacco industry in 1929-30 considered the following costs to represent the actual outlay involved in raising one acre of an average tobacco crop:—

Witness A—Myrtleford	£40	18	9
Witness B—Tumut	45	17	0
Witness C—Corryong	56	3	0

Mr. W. H. Brew, a certified accountant associated with the Customs and Tariff Board, gives the cost of producing tobacco in Victoria as £45 4s., while a former tobacco expert of this Department, Mr. T. A. J. Smith, considers the cost to be £45 13s. per acre.

The bulk of evidence appears to indicate that £45 is a fair average charge against one acre of crop. The probable returns from an acre of average crop are indicated in later calculations.

TABLE V.—TOTAL IMPORTS OF TOBACCO-LEAF, U.S.A., 1925 TO 1930.

1925.	1926.	1927.	1928.	1929.	1930.
lb.	lb.	lb.	lb.	lb.	lb.
103,027,000	99,882,000	133,616,000	100,562,000	98,523,000	96,491,000

Average yearly imports = 105,350,000 lb.

Total average consumption of tobacco-leaf produced in U.S.A. 1925 to 1929 = 837,014,000 lb.

Tobacco leaf strung ready for curing.

In many Victorian districts where tobacco is already established, there are various means by which the farmer can considerably supplement his income—for example, fruit-growing and dairying in the Shepparton district, or dairying and summer crops in the North-east. Under such conditions there is not the same risk attached to land purchase as is the case in districts where the tobacco crop is the only source of income. It is in these latter districts, however, that the natural environment best suited to the production of bright flue-cured leaf is found. The lack of other agricultural avenues to be exploited in such districts limits the purchase price of land to a figure that would not necessitate a drastic writing off of capital should the price of tobacco leaf reach a permanently lower level.

A possible income obtainable from a property of 35 acres in a district of this nature is considered to be as follows. The calculations are based on the assumption that of the total area of 35 acres, 15 acres is cropped annually to tobacco, 15 acres fallowed, and the remainder utilized for dwellings, buildings, and stock-yard, &c.:—

CAPITAL EXPENDITURE—						
Land, 35 acres, at £10 per acre				£350	0	0
Cost of clearing at £10 per acre				350	0	0
Fencing				96	5	0
Barns (two)				190	0	0
Shed				100	0	0
Stable				30	0	0
Implements				150	0	0
Horses, three at £25 each				75	0	0
Capital invested				£1,341	5	0
ANNUAL EXPENDITURE—						
Interest on capital at 5 per cent.	£67	1	3			
Depreciation on horses at 10 per cent.	7	5	0			
Depreciation on machinery at 10 per cent.	15	0	0			
Depreciation on buildings at at 7 per cent.	22	8	0			
				£111	14	3
Feed for horses, 15 tons, at £3 10s. per ton	52	10	0			
Fertilizer at £1 per acre	15	0	0			
*Plants, 100,000, at £1 per 1,000	100	0	0			
*Wood, 30 cords, at £1 per cord	30	0	0			
Hessian, twine, &c.	4	10	0			
				£202	0	0
Carried forward				£313	14	3

* A considerable saving could be effected in these items if the farmer were to grow his own plants and save stocks of wood while clearing his property.

Brought forward				£313	14	3
HIRED LABOUR—						
One man, 24 weeks, at £3 per week	£72	0	0			
One man, 4 weeks, at £3 per week (transplanting) ..	12	0	0			
Two men, 10 weeks, at £3 per week (harvesting) ..	60	0	0			
				£144	0	0
Rates and taxes	£10	0	0			
Repairs to machinery ..	10	0	0			
Contingencies ..	20	0	0			
Freight, 3¾ tons, at £2 5s. per ton	8	8	9			
Cartage, 3¾ tons, 10 miles, at 1s. per ton mile	1	17	6			
				£50	6	3
Total ..				£508	0	6

This sum of £508 0s. 6d. does not include the value of the farmer's labour and management, so that, irrespective of his own labour, the actual cost to the farmer of growing 15 acres of tobacco will be £508 0s. 6d., or £33 17s. 4d. per acre.

Taking the average yield of 561 lb. over the whole State for the last ten years as the acre return from this hypothetical property, the actual cost to the farmer of producing 1 lb. of leaf works out at 14.4d., plus the value of his own labour. The farmer's income then is provided by the amount in excess of 14.4d. per lb. paid for his leaf, every additional penny representing a return of £2 6s. 9d. per acre. At the recently suggested price of 2s. 3d. per lb., the farmer's income in this particular case would be £441 15s. 9d., or £336 2s. at an average of 2s. per lb.

If the value of the farmer's labour be assessed at £3 per week for 52 weeks, the cost of producing tobacco on this property will be £44 9s. 4d. per acre.

TABLE VI.—SHOWING RAPIDITY OF INCREASED PRODUCTION OF TOBACCO IN VARIOUS COUNTRIES.

—	1918.	1926.	Increase.
	lb.	lb.	
Southern Rhodesia	620,000	19,000,000	30 times
Northern Rhodesia	445,000	2,000,000	4½ times
Nyasaland ..	2,594,000	11,000,000	4½ times
Canada	14,000,000	28,000,000	Twice
Union of South Africa ..	14,931,000	19,000,000	1¼ times

One Man Proposition.

With some additional labour at harvest and curing, one man can handle 5 acres of crop. The farmer himself would be employed fully throughout only eight months of the year. If £44 9s. 4d. be taken as the cost of producing one acre of tobacco,* the cost of producing 5 acres would be £222 6s. 8d. An average yield of 561 lb. of leaf at 2s. 3d. per lb. would furnish gross returns of £315 11s. 3d. Net returns, therefore, are £93 4s. 7d.

Included in the figure of £222 6s. 8d. is the value of the farmer's labour for eight months, which, on the basis previously established of £156 per annum, equals £104. The total return to the farmer then is £104, plus £93 4s. 7d., or £197 4s. 7d.

Owing to the risk of a total or considerable loss through blue mould or other causes, the prospective grower should be assured of sufficient finance to enable him to grow a second crop should his first be a total failure.

* This figure is based on the calculations made for fifteen acres of tobacco, and would be only approximately correct for the five-acres proposition.

The Poultry Industry

A publication on the Poultry Industry has been issued by the Department of Agriculture. The book, which is intended to take the place of the Departmental bulletin now out of print, deals comprehensively with poultry farming from the establishment of the farm to the marketing of eggs and birds. Several of the articles originally appeared in this *Journal*. The price of the publication is 2s. 6d. (posted, 2s. 8d.).

The Pollination of Fruit Trees

By A. G. Strickland, M.Agr.Sc., Horticultural Research Officer.

THE question of pollination is one of the utmost importance to the fruit-grower, and one worthy of the fullest consideration when new plantings are being made or when trees are not cropping as fully as they should. Before the days of extensive apple export, many varieties of fruits were grown in a jumbled mass, and satisfactory crops were general. When, however, it was found necessary to confine fruit-growing to a few selected varieties, growers began to strike trouble. Modern fruit-growing tends to the planting of a few varieties, and we have many instances of defective pollination, and consequent reduced crops from this cause.

When trees blossom profusely, and yet fail to set more than a few fruits, lack of pollination should be suspected immediately as a likely reason. This failure of blossoms to set, however, is not always due to faulty pollination, and other factors such as frost, cold, windy and wet weather at flowering time, disease and insect injury to blossoms, may all have an influence. Soil conditions, as well as pruning practices which upset the balance of tree feeding, also contribute towards poor setting, and such factors must be considered before finally attributing low yields to faulty pollination. In cases where these conditions are apparently favorable, and fruit still does not set, it is more than probable that pollination conditions are at fault.

Flower Structure.

In order to appreciate these problems, some knowledge of the flower structure, and of the mechanism of fruit formation, is necessary.

Fruit is most often accompanied by seed, and the production of seed is essentially a sexual process. Blossoms are provided with male and female sexual organs, and in the perfect flower both types of organ are present in the one blossom. The male organs, or stamens, have as their function the production of large numbers of tiny pollen grains, which are shed when ripe. The female organ or pistil consists of a seed case at the base of the flower, containing bodies which will later develop into seeds if fertilized in the normal manner. These bodies are called ovules, and are really immature egg cells. This seed case is surmounted by a long stem, bearing at the top a sticky bulb or stigma; the function of this sticky stigma is to pick up pollen grains which may fall on it, or which may be brought to the flower by bees and other insects. When a pollen grain lodges on the stigma, it is stimulated to send out a fine tube which grows down the stem of the stigma, and, conditions being favorable, eventually reaches the bodies in the seed case, with which bodies the contents of the pollen grain fuse. This process is termed *fertilization,* and is the final step in enabling the ovules in the seed case to ripen into viable seeds.

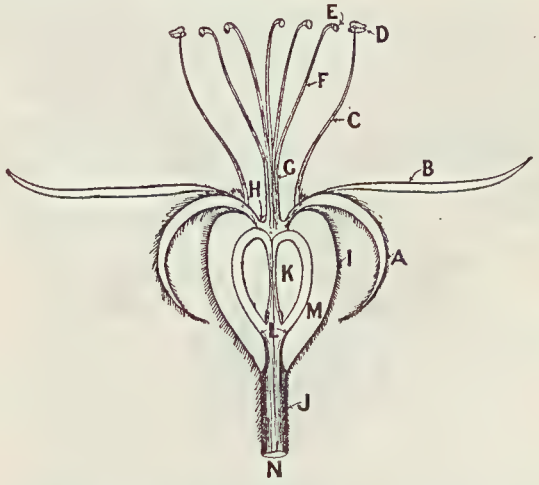


Diagram of longitudinal section of apple flower.

A, The sepal; B, The petal; C, The stamens; D, The anther; E, The stigma; F, The style; G, Union of the pistil divisions; H, The nectary; I, The rind; J, The stem; K, The ovule; L, The ovary; M, The fleshy part, and N, Point of union with the parent twig.

When fertilization has taken place, swelling of the flower parts immediately commences—in other words, the fruit has "set"; but should fertilization not take place within a certain period, the flower drops off the tree, and no fruit is formed.

The term pollination describes the application of pollen to the stigma, but in order to obtain fruit, the further process of fertilization is also necessary.

A flower may be fertilized by its own pollen, or pollen from another flower of the same variety, in which case it is said to be *self-fertilized.* When it is fertilized by pollen

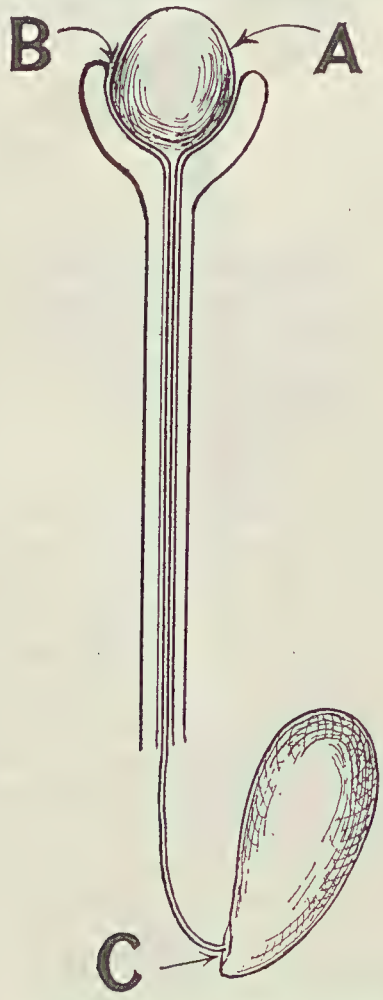


Diagram showing action of pollen grain during the process of fertilization (highly enlarged). A, Pollen grain; B, Stigma; C, Ovule.

from flowers of a different variety it is *cross-fertilized.* Some fruits will set fruit when self-fertilized, and these are termed *self-fruitful;* others, which must be cross-fertilized in order to set fruit, are in the *self-unfruitful* class. This latter is the class with which the orchardist is most concerned.

The planting of self-unfruitful plants in solid blocks, without any provision for cross pollination must result in reduced yields. Ideal fruits are those which require no pollination, such as navel oranges, bananas, sultanas, &c. In these cases seedlessness is a valuable characteristic. The same phenomenon is by no means uncommon in certain apples and pears, but is of no commercial importance, as these seedless apples and pears still have the usual tough and inedible core.

This capacity of some apple and pear varieties to set fruit without pollination is illustrated by the behaviour of Williams Bon Chretien pears in the Goulburn Valley, where seedless pears are very common. Golden Spire and Sturmer apples as well as many others have this capacity for producing seedless fruits developed to a certain extent.

Next to the fruits which require no pollination, the most ideal are those which require only self-pollination, i.e., they are self-fruitful. Peaches and apricots are, in the main, self-fruitful, and require no interplanting. Most of our varieties of apples, pears, cherries, and plums, however, are self-unfruitful or partially so. When a fruit variety is partially self-unfruitful it will set some fruits with its own pollen, but for maximum cropping cross-fertilization is necessary.

Another complexity occurs in that a certain variety may be self-fruitful in one district and self-unfruitful in another. For example, the Williams pear benefits from cross-pollination in southern Victoria, and yet sets splendid crops in the Goulburn Valley without any provision for cross-pollination. This particular variety behaves similarly in the United States of America, where it sets a medium crop without cross-pollination under coastal and interior valley conditions, whilst it is entirely self-unfruitful on the Sierra Nevada foot hills.

Causes of Self-unfruitfulness.

There are two main conditions which will make a variety dependent upon cross-fertilization for the setting of fruit. These are—

(*a*) *Pollen Sterility.*—In this case stamens are imperfect or absent, and either no pollen is formed, or such that is formed is shrivelled, and incapable of bringing about fertilization. As an example we have La Marguerite strawberry, which is without stamens, and therefore incapable of producing pollen. To secure crops from La

Marguerite, another variety must be planted nearby in order to provide pollen. In the Gravenstein apple we have a flower which produces pollen, but this pollen is of very poor quality, and only very few grains are capable of fertilizing another flower. This

One method of bagging to determine self-fruitfulness.

explains why the Gravenstein is of very little use as a pollinating agent, and also why it needs another variety to pollinate itself, in order to obtain maximum crops.

(*b*) *Incompatibility.* — The second and most general cause of unfruitfulness is incompatibility. In this case the flower is perfect, pollination may take place normally, i.e., pollen may lodge on the stigma, but no fruit results. In other words, the variety produces its own pollen, and quite often strong pollen at that (as distinct from varieties such as Gravenstein), but will not set fruit with its own pollen. In extreme cases this self-incompatibility is complete, and we have a completely self-unfruitful variety, but in the majority of cases the incompatibility is only partial. That is to say, the variety will set a certain number of fruits by self-pollination, with no assistance from extraneous pollen. This is the case with many of our varieties of apples, pears, and plums.

As well as this phenomena of self-incompatibility, there exists also cross-incompatibility between varieties. In other words, certain varieties are of no use for cross-fertilizing certain other varieties, e.g., the European type of plum is of no use for pollinating the Japanese type. Here again we may get degrees of cross-incompatibility, and some pairs of varieties are only partially cross-incompatible, i.e., they will set a limited number of fruits when cross-pollinated, but for maximum crops need other varieties with which they are compatible.

The question may be asked—Why are varieties self-incompatible or cross-incompatible? It is easy to see why fruit cannot be set, if there is no pollen available, or if the pollen available is incapable of germinating, but it is not so evident why fruit will not set even when good pollen has lodged on the stigma and sent out its germ tube. Microscopical examination of cases of incompatibility has shown that the pollen often actually germinates, and sends a tube down the stigma, but that this tube does not get very far. After traversing a short distance its growth ceases, and as it cannot then reach the egg cells or ovules of the flower, fertilization does not take place. Pollination has occurred, but the final process of fertilization is impossible. Just why the tube will not grow in the stigma of an incompatible variety has not been definitely determined, but it is thought to be due to the presence of a chemical substance which stops its growth.

The foregoing remarks may be summarized as follows:—

(*a*) Some fruit varieties are fully self-fruitful, and may be grown in solid blocks without reduction in yield, e.g., peaches and apricots.

(*b*) Most varieties are fully or partially self-unfruitful, and must be planted in mixed blocks in order to get maximum crops, e.g., apples, pears, and plums.

(*c*) Some varieties are cross-incompatible with other varieties, and therefore of no use for inter-planting with the varieties with which they happen to be incompatible. Furthermore, some varieties (such as Gravenstein) will not produce good pollen, should not be used as pollenizers.

Factors Influencing Effective Pollination.

Proper pollination of fruit trees is dependent on—

1. The presence of suitable varieties for inter-pollination if the main variety is self-unfruitful.

2. The presence of insects, such as bees, to enable the distribution of pollen from flower to flower. Wind is quite unimportant in distributing pollen, except in the case of nuts, and it may be said that 99 per cent. of all fertilized blooms owe their pollination to bees and other insects—the remaining 1 per cent., which is negligible, may be due to wind. It is therefore important that bees should be present in the orchard. Under favorable conditions, there may be plenty of insects and bees in the orchard, but when the weather is not suitable there may be insufficient to ensure proper pollination, and for this reason, it is advisable to make arrangements for the distribution of hives during the blooming period. It is generally considered that one hive of bees to each acre of mature trees is sufficient to ensure effective pollen distribution. During last blossoming season it was noticeable that owing to bad weather conditions the bees were not very active in some localities, and it is possible that this was one of the causes of the light crop.

3. Where inter-pollination is necessary, the inter-pollinating varieties must bloom at the same time, and, moreover, it is advisable for their blossoming periods to overlap at least one week, as seasonal variations may cause slight fluctuations from recorded blooming dates. This necessity is one of the most obvious, and yet in the past mistakes have been made, such as planting Rome Beauty with Jonathan, although the latter variety finishes blooming before the blossoms of the Rome Beautys are even open. In Bulletin No. 58* of the Victorian Department of Agriculture, the blooming dates of fruit varieties in several districts are tabulated in detail, and from a study of these dates it is a simple matter to determine varieties which bloom simultaneously. In selecting varieties for inter-pollination, it must be remembered that, because two varieties blossom at the same time or slightly overlap, it does not follow that they are suitable for cross-pollination. The questions of compatibility and pollen sterility, previously referred to, must also be considered. For instance, Gravenstein flowers at the same time as Jonathan, but is not recommended as a pollenizer for Jonathan, because its pollen is of very poor quality. Then again, we may have a European plum flowering simultaneously with a Japanese plum, but they will not pollinate each other, as the pollen of the one is not acceptable to the pistils of the other. We know very little regarding the incompatibility between varieties in Australia, but a start has been made on this work, and results are hoped for in the ensuing few years. At present, we are guided more or less by general experience, and the work of overseas investigators, but care has to be taken in interpreting foreign experiments, as that which applies in other countries does not always apply in Australia. For instance, the Keiffer pear is self-fruitful in some parts of America, but we could not say that it is self-fruitful in Victoria.

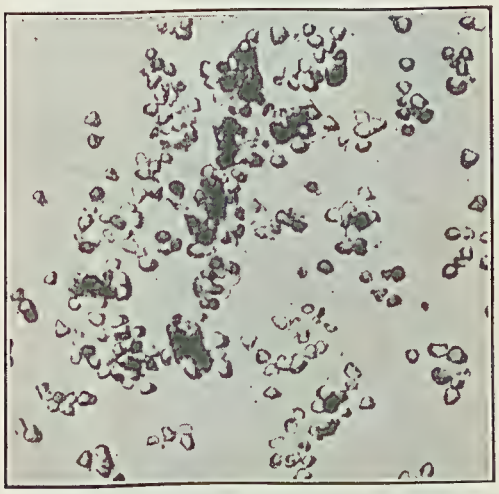
Determining information on the fruitfulness of varieties entails a considerable amount of work, and requires many years' careful experiment. A start has been made on pollen germination tests, bagging experiments, &c. Although such experiments may not yield definite information for several years, the results so far obtained are of value. Owing to the light season just experienced, the work has been interfered with, but the results of the 1931-32 season may yield valuable information when compared with a normal season.

Pollen Germination Trials.

It will be remembered that proper fertilization of a flower is dependent on the pollen grain germinating, and sending out a tube which is to make contact with the incipient seeds or ovules. If the pollen is unable to do this, it is useless. Now the capacity of pollen to germinate may be tested in the laboratory. If pollen grains be strewn on the surface of a jelly containing sugar, they will germinate and send out tubes just as they do on the stigma. By examining these grains under the microscope, the number of tubes may be counted, and a measure of the strength of the pollen obtained. Those varieties whose pollen gives a high percentage of germination and long pollen tubes are good pollenizers. Among such varieties probably are included Rokewood, Granny Smith, Jonathan, Rome Beauty,

*Bulln. No. 58, "Planting Fruit Trees for Inter-pollination," will be forwarded to any address on prepayment of 5d. in postage stamps.

&c. On the other hand, there are varieties whose pollen has a very low percentage germination, and such varieties consequently are poor pollenizers. As instances, we have Gravenstein and Rhode Island Greening apples and Brande's Jordan Almond.



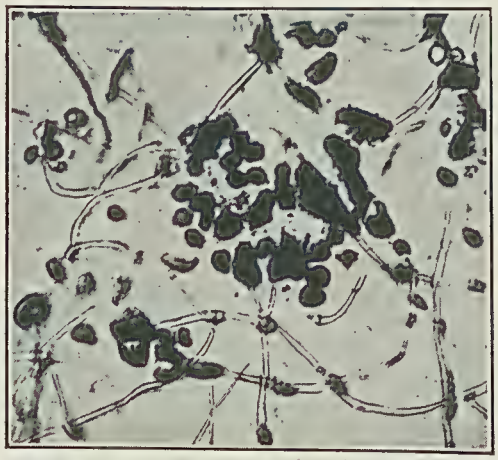
Germination of pollen of a poor pollinating variety (e.g., Gravenstein) on sugar-agar media. Note failure of practically all grains to germinate.

During last spring, pollen germination tests were carried out on a number of apple varieties, and on some berries. As this was the first season of the trials, the results cannot be quoted unreservedly, but as they proved to be quite unexpected; some reference to them will be made. Very light apple crops were obtained this season, and the blame was largely attributed to the thrips invasion; however, it has been held that thrips were not responsible for all the damage, and that the remarkably wet season played at least some part. From the germination percentages obtained, it certainly appears that the pollen of all varieties was markedly lower in vitality than in a normal season. There are no other published Australian figures to be compared with those obtained in this test, and the results will have to be checked up with figures obtained in ensuing years. Nevertheless, we find from investigations in other countries that many apple varieties give pollen germinating up to 99 per cent. In our investigations this season the highest percentage obtained was 40 per cent. approximately, indicating (but not proving) that pollen was weak last spring. This information is not advanced as having been definitely proved until we have checked up with other seasons, but it certainly seems that we have here one factor operating in the 1931 crop failure. In the cases of Gravenstein and Reinette du Canada not one pollen grain germinated.

In certain cases better crops were obtained this season where pollination facilities were especially good, and this possibly may be explained by the low vitality of pollen in most varieties and the bad conditions for bee activity during the blooming period. Under conditions where pollenizers were frequent, the smaller percentage of good pollen and the scarcity of bees would not limit fertilization so much.

We will now deal briefly with the various fruits, indicating, as far as possible, their pollination requirements:—

Apples.—Nearly all varieties of apples are partially or completely self-unfruitful, and it is generally admitted that no single variety can be advantageously planted alone. It may be held that in certain seasons and under certain local conditions, Jonathan, London Pippin, and others may set good crops without the aid of cross-pollination; the reason for all discrepancies is not known, but the fact remains that better and more regular crops will result if such varieties are interplanted. Work in every part of the world has shown that there are no decided cases of cross-unfruitfulness in apples. This means that with the exception of varieties which produce poor pollen (such as Gravenstein) most apple



Germination of pollen of a good pollinating variety on sugar-agar media. Note abundant germination and long narrow tubes.

varieties which bloom together will inter-pollinate each other satisfactorily. Notable varieties with poor pollen are Gravenstein, Rhode Island Greening, Baldwin, and, possibly, Tasma and Reinette du Canada. After a further season's work other varieties may be found to produce weak pollen. The weakness of Gravenstein pollen is borne out in practice, and Gravenstein is a notoriously poor pollenizer. In the few cases where is has proved satisfactory, this may be put down to conditions favorable for bee activity, and the abundant transfer of pollen. Under such conditions each stigma would be loaded with pollen grains, one or more of which may be capable of germinating. There are few seasons, however, that such ideal conditions are experienced, and on the whole Gravenstein is useless as a pollenizer.

It may be said generally that so far as apples are concerned, varieties which produce good pollen, and which bloom at the same time, are suitable for interplanting.

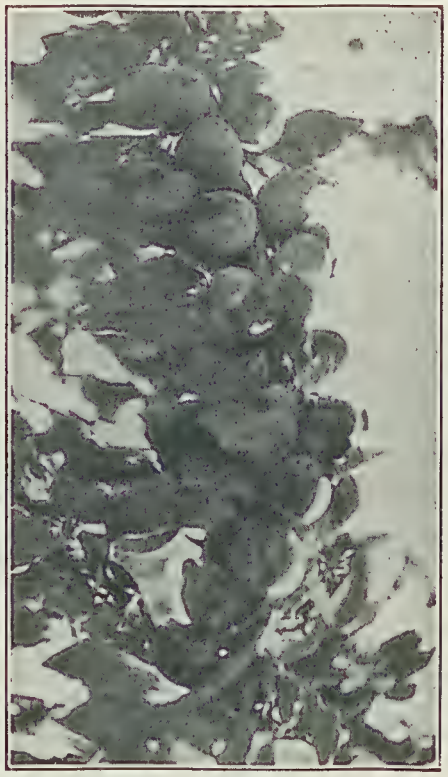
Pears.—Many varieties of pears are planted on the assumption that they are self-fruitful, but it must be remembered that self-fruitfulness varies with the season, district, and climate, and that no hard and fast separation of self-fruitful from self-unfruitful varieties is possible.

As an instance, we have the case of Williams Bon Chretien Pear already referred to. This variety seems to be self-fruitful in the Goulburn Valley, and self-unfruitful in southern districts generally. In the south, Williams should be interplanted with Winter Nelis, Beurre Bosc, or Doyenne du Comice. In northern districts Williams is capable of setting seedless fruits without fertilization as well as fruits from self-pollination.

Keiffer is reported as self-unfruitful in some parts of the United States of America, and such is our experience in Victoria. Kieffer should be pollinated with Howell. Many other pear varieties are partially self-unfruitful, and should be interplanted with varieties blossoming simultaneously.

No Australian data on pollen vitality is available for pears, but work in other countries seems to show that Beurre Clairgeau is not particularly good in this respect.

Plums (*Japanese*).—Many varieties of Japanese plums are self-unfruitful, and should not be planted in solid blocks. Included in the list of self-unfruitful varieties we have Abundance, Satsuma, Burbank, Wickson, Kelsey, Formosa, and Gaviota. Climax, however, is in many cases self-fruitful. Practically all Japanese plums are cross-fruitful, and may be interplanted for pollination purposes with the exception of Formosa and Gaviota. These two latter varieties are intersterile, and should not be planted together.



A branch from a Sugar Prune, grown at Mildura, showing the effects of cross pollination with Robe de Sergeant.

European Plums.—Several varieties of European plums are self-unfruitful, and require interplanting, e.g., Clyman, Tragedy, Grand Duke, Golden Drop, President, Robe de Sergeant, &c. Prune d'Agen, Sugar, &c., are self-fertile, and set quite well without inter-pollination. Most European plums are suitable for inter-pollination, provided that they flower simultaneously. As a general rule, Japanese plums do not cross-pollinate with the European type, although in the United States of America Burbank has set well when pollinated with the European variety Reine Claude du Bavay. Golden Drop and Jefferson have been proved cross-unfruitful in England.

Cherries.—The important sour cherries, English Morello, Montmorency, and Early Richmond, are self-fruitful, but may benefit slightly from interplanting. All sweet cherries, Black Tartarian, Early Purple, Florence, &c., are self-unfruitful, and require interplanting. Bing, Lambert, and Napoleon are also inter-sterile, and will not pollinate each other.

Stone Fruits.—With few exceptions, peach and apricot varieties are self-fruitful, and satisfactory crops are obtained without interplanting. In the United States of America there are two notable exceptions—J. H. Hales and June Elberta peach, which set no fruit without cross-fertilization. These two varieties are pollen sterile, and are useless as pollenizers for other varieties, as well as being themselves self-fruitless. All varieties of apricots are sufficiently self-fruitful to set good crops.

Most varieties of almonds are self-unfruitful and need pollenizers. In the pollen germination tests this season, Brande's Jordan was shown to have very weak pollen, indicating that it is of no value as a pollinating variety.

Provision of Pollenizers.

It has been shown that many of our apples and pears, plums, almonds, and cherries are partially self-unfruitful or wholly so, and require inter-pollenizers.

The general recommendation in regard to interplanting is to have no tree more than two trees distant from the desired pollinating variety. Two solid rows and then either one or two rows of the pollenizer is a satisfactory lay-out. If mixed planting is not an objection, every third tree in every third row will provide nearby pollenizers.

Where there is insufficient provision for inter-pollination in an established orchard, pollinating varieties may be grafted on limbs of trees at suitable intervals through the orchard, or whole trees may be grafted over. Grafts should be inserted fairly high up on the limbs of old trees, as if they are inserted too low a large cut surface, which may not heal well, is exposed. If the grafts are pruned lightly each year, plentiful blossom should be available in a few years.

As a temporary expedient and to tide over the period before the grafted trees provide blossoms, fair-sized branches with flowers of the desired pollinating varieties should be placed in petrol tins of water at suitable intervals through the orchard. These will do service for about one week, and should be replaced periodically during the flowering period.

The most important points may be summarized as follow:—

1. In planting orchards of apples, pears, plums, cherries, almonds, &c., choose two or more varieties that flower at the same time, avoiding, however, varieties which are not compatible with each other.
2. Where trees of one variety are in a solid block and are not fully productive, interplant or graft another variety, in order to provide adequate pollination facilities.
3. If there is evidence of scarcity of bees to act as pollen carriers from tree to tree, make arrangements for the distribution of hives in the orchard during the blooming period.

Book Review

"The Use of Fertilizers in Tropical and Sub-tropical Agriculture." A. Jacobs & V. Coyle (Ernest Benn Ltd.), 1931 (pp. 272, price 10s. 6d. in England).

The authors' aim to supply, in handy and condensed form, information at present scattered throughout scientific literature on the manuring of crops in tropical and sub-tropical climates, and in this they have succeeded, if not exhaustively, at least sufficiently to indicate to farmers and others the necessity for the adequate use of fertilizers and the type of success that may be expected in consequence.

The first part of the book is devoted to a short general discussion of fertilizers and their relation to plant growth, and describes different classes of fertilizers, tropical soils, and the conduct of manurial experiment. The second and larger portion is devoted to the manuring of specific crops such as grain, sugar cane, tobacco, tea, rubber, fruit, and vegetables. In each case the general requirements of the crop are enumerated, followed by the results of field trials, and a general recommendation as to fertilizer mixtures likely to prove satisfactory. Unfortunately, in many instances, the field trials described appear to be from farmers' plots, rather than from agricultural institutions.

The book is a convenient summary of the manurial requirements of tropical and sub-tropical crops and should be of value to interested agriculturists, both scientific and practical. Its value to Victorian agriculture, under quite different climatic conditions, is obviously strictly limited. The printing and illustrations are excellent.

Orchard and Garden Notes

By Edward E. Pescott, F.L.S.

The Flower Garden.

IN planting out bulbs for spring flowering, it should be remembered that these plants are quick growing, and that their roots have a very limited soil area. Therefore, a good supply of food should be given to the soil before planting the bulbs.

The best fertilizer is one or other of the animal manures (except poultry manure) well rotted down. It should be dug into the soil below the bulb, where the roots can readily reach it and feed upon it.

Bulbs should not be planted at too shallow a depth; place the tips from 3 to 4 inches from the surface; while in a light soil, hyacinths and tulips may be planted even a couple of inches deeper.

Before winter sets in, and while the soil is still warm, some shrub and tree planting may be done. In setting out these plants from pots, see that the roots are well spread out in the soil, and not allowed to remain in the curled position, in which they are usually grown in the pots.

The ever-popular scarlet flowering gum (*Eucalyptus ficifolia*) is much in demand. This rich flowering tree gives an abundance of bloom in mid-summer. It is a native of the sandy parts of Western Australia, and consequently loves a sandy soil. If it is desired to plant this tree in heavy land, a good admixture of sand should be worked into the soil before planting the trees.

If red-flowered gums are required for autumn and winter flowering, the red-flowered ironbark (*Eucalyptus leucoxylon rosea*) is the one to plant. This is a dwarf tree, of good habit, and bears beautiful flowers.

The Western Australian Flowering Gum.

Gladioli corms should be lifted and dried off. A few days after lifting, the stems and leaves should be cut off, and the corms stored away in boxes; before storing a light lime dusting should be given.

The Vegetable Garden.

This is now a good time for planting out rhubarb roots. Before planting, the bed or border should be made very rich with stable manure. It is hardly possible to make the beds too rich, provided the soil is still drainable. Set the roots in the soil, and trample them in after filling in the earth.

A few turnip, spinach, and early peas may be sown. Broad beans may be sown largely for a main crop. Lime-dust the seeds before covering over with soil to keep away soil pests. Mustard and cress, lettuce and radish may be sown for succession crops.

The Orchard.

In apple and pear orchards, it will be advisable to clear out codlin moth from their hiding places, and not allow them to remain till spring. All crevices should be cleaned out, and old cases likely to be contaminated should be treated with steam or burned. Lime dressings are now to be given among the trees, from 5 to 6 cwt. per acre should be applied; and although late, it is not too late to sow crops for green manures, especially in warm districts.

Professional Papers

[This section is devoted to professional papers and articles of a scientific character.]

Irrigated Pastures

Rate and Frequency of Watering Tests

By L. C. Bartels, B.Agr.Sc., Senior Irrigation Officer, E. T. Beruldsen, B.Sc. (Ag.), and A. Morgan, B.Agr.Sc., State Research Farm, Werribee.

THAT mixed grasses and clovers are likely to become the most important crop grown under irrigation conditions in Victoria is suggested by the remarkable extension in the area sown during the last few years, as well as by the good results obtained under a wide variety of conditions by dairy-farmers and pastoralists. This development has been sponsored by the Department of Agriculture after prolonged tests at Werribee and in other districts.

At the Werribee Research Farm, mixed grasses and clovers sown in 1913 have maintained high productivity and now present pasture in better condition than ever. The trials of different species have given an opportunity to study their suitability for irrigation conditions, and the seeding mixtures recommended by the Department are based on these observations.

Perennial rye-grass, cocksfoot, fescues, meadow foxtail, and Kentucky blue-grass have persisted well; timothy and tall oat-grass are less conspicuous than formerly; prairie grass and Italian rye-grass sometimes show prominently; white clover has proved itself of outstanding worth; strawberry clover and subterranean clover are very good; perennial red clover (cowgrass) and alsike clover do not last beyond five or six years, while most of the annual clovers and medicks figure prominently in irrigated pastures if conditions are not made favorable for the perennial species.

It is obvious that since an association of the above-mentioned species can be established and maintained pastures of high quality result. These pastures have proved themselves long-lived and productive—they provide variety and continuity of feed, and they possess what might be termed "resiliency" in that disturbance in conditions will not affect all the species to the same extent.

From the initial test-plots established in 1913 the acreage under seeded pasture on the Research Farm has been extended till there is now an area of 400 acres. A large part of this land was originally seeded to lucerne, and grasses and clovers have grown particularly well in succession, but splendid pastures have been established on parts of the farm which are heavy-soiled, low-lying, and otherwise unsuitable for lucerne.

The influence of regular watering was apparent from the outset of the trials, the value of liberal manuring was soon learned, and observations made by Mr. E. J. Thomas, B.Sc., B.Agr.Sc., B.V.Sc., in his feeding trials with dairy cows in 1925 and 1926, gave early knowledge of the high yields and high nutritive value of pasture clipped at monthly intervals. The necessity for obtaining more precise information regarding the factors governing the growth and character of irrigated pastures was manifest, and in 1925, tests on pasture were initiated at Werribee. Prior to that, most of the irrigation experiments had been conducted with lucerne, but the termination of a series of lucerne tests in the previous year gave the desired opportunity. A 10-acre field with favorable contours was available. It had two concrete water channels, one at the top of the field and one across the centre; at the head of each was a modified Dethridge water meter. The field was laid out on the "border" system, in bays bordered by check-banks at half-chain intervals.

The soil on this pasture area is a clay loam of alluvial origin. Although well suited for

irrigation, the surface sets when dry and it is difficult to plough. For the same reason it does not absorb irrigation water freely. In profile the surface soil shows a depth of 6 or 7 inches, and underlying this is a subsoil band of reddish clay which extends to an average depth of 2 feet. This clay band is traversed by cracks. It is succeeded by a fine sandy stratum of variable thickness, but with an average width of 18 inches. In places nodules of limestone are found at the junction of the clay loam and the sandy layer, and usually nodules are scattered through the latter. The sandy layer is succeeded by red clay. Blue pug clay occurs at a depth of 10 feet. As a result of a heavy dressing of lime prior to the commencement of the pasture investigations, the surface soil to a depth of 9 inches now possesses a highly alkaline reaction (average pH 7.5.)

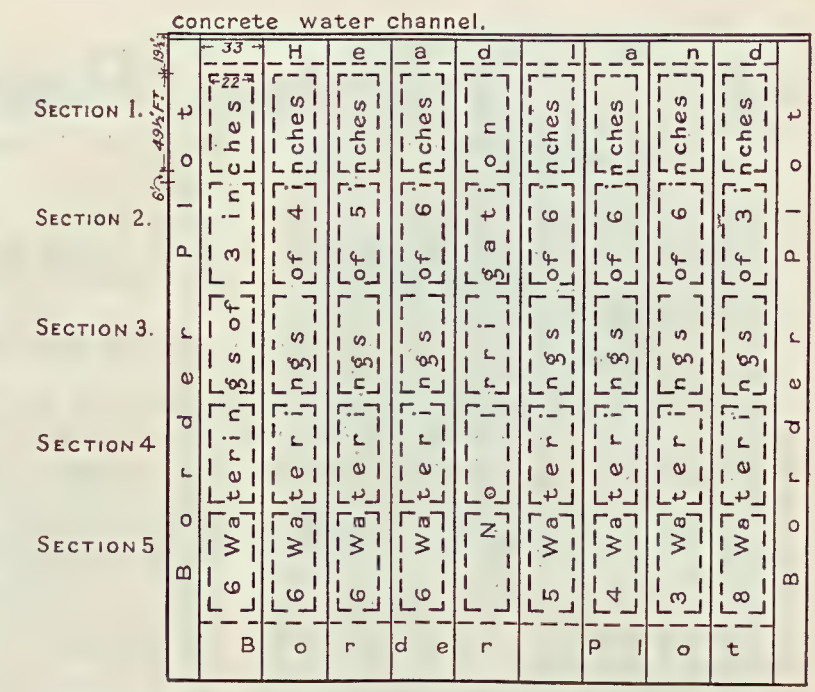


Diagram 1.—Layout of the rate and frequency of watering tests.

When the lucerne was ploughed out in the autumn of 1924, a crop of barley was sown, without manure. When that was taken off the land was ploughed and left in bare fallow, and after working down and regrading the field was sown in September, 1925, with the following mixture:—

	Lb. Per Acre.
Perennial rye-grass	12
Westernwolths rye-grass	3
Cocksfoot	3
Prairie grass	1½
Bromus inermis	1½
Lucerne	3
Alsike	2
Perennial red clover	2
White clover	1
English wild white clover	1
Subterranean clover	1

The experiments embraced variety trials, manurial tests, and rate and frequency of watering tests. The lay-out of the latter was designed to nullify any possible residual influence from the preceding lucerne plots.

Seasonal conditions subsequent to sowing in 1925 were not favorable, and early irrigation was necessary to preserve the young pasture. For the same reason, the schedule of waterings designed for the irrigation test plots could not be adopted during the first season, because of the necessity of getting the young plants established, hence all the bays were watered evenly. Since the spring of 1926 the specified rates and frequencies of watering have been consistently followed.

In the conduct of these pasture trials, it has been fully recognized that a proper interpretation of the results demands the introduction of grazing animals, so that production may be measured in carrying capacity or in terms of beef, mutton, milk, butter, or wool. The effect of the pastures on the animals is one phase, but the effect of the animals on the pasture is an equally important one. Any worker on pasture problems knows how difficult it is to study these problems effectively, hence the variety of methods adopted. These difficulties impose limitations on the efficiency

Cutting the "Rate and Frequency of Watering" plots with the motor mower.

of such experiments, but the aim at Werribee is to study the several problems independently and to correlate the results from different methods. At the outset it was decided to graze with sheep, but because of the comprehensive nature of the tests it was impracticable to enclose each plot with a view to grazing each separately. Moreover, the need for sufficient numbers of animals to obviate errors due to animal individualities, the difficulties of adjusting numbers, regulating movements, and determining the reaction to conditions on a particular plot, limit such an experiment to the simplest comparisons or demand the replication of the plots until they are unwieldy.

The plots, then, were primarily observation tests, but it was hoped that by keeping the stock off in the spring the resultant growth could be harvested and the yield of hay taken as a measure of the production due to the various treatments. This was done for three seasons, but the inadequacy of the method was apparent. Yields of hay did not reflect the apparent differences in the growth of the various plots observed during the year.

In 1929 it was decided to adopt the lawn-mowing method of determining production, and since September, 1929, this method has been in continuous use. Mowing is an attempt to imitate hard grazing at frequent intervals, and, despite the obvious dissimilarities between the animal and its imitation, its use has had very successful results which have given a new conception of the productive capacity of irrigated grasses and clovers as well as providing a measure of the effects of the different treatments.

A 24-inch "Atco" motor-mower has been used. In all cases where plots are mowed borders are left all round and the usual procedure is to mow the headlands very closely before the mowing of the plot itself. Inasmuch as the growth on the plots is sometimes 3 or 4 inches high one mowing does not always give a satisfactory result—because of this all the plots are gone over twice. The green clippings are weighed immediately after cutting, and after thorough mixing samples are forwarded in air-tight tins for analysis by the departmental chemists. Each year the plots have been top-dressed with 2 cwt. superphosphate per acre. The times and amounts of waterings during the two seasons under review (1929-30 and 1930-31) are shown in Table I.

It should be explained that it is difficult to get more than 3 inches of water into the soil on these plots at a watering, and quantities above that amount have to be applied by means of "supplementary" waterings. This method, however, possesses advantages in regard to the even distribution of the applied water.

From the outset, the differing water practices on the various bays induced varying growths on the plots, not only in respect of yield, but also in respect of the continuity of production and in the composition and character of the herbage. These influences, marked at the start, were cumulative in their effects

and to some extent variable according to seasonal conditions. In this respect the main data concerning the two seasons under review are given, and their effects discussed in the later sections of this report.

Any complete investigation into the influence of varying rates and frequencies of irrigation on pastures must take cognizance not only of resultant yields, but also of the botanical and chemical composition of the herbage, the responses of the various species under test, and the seasonal periodicities of growth (which might be conveniently termed the "succession"). With a knowledge of the fodder value of the produce a more complete understanding is possible.

In an attempt to picture the composition of the various pasture types systematic botanical surveys by means of the "percentage estimation" method (for a description of which see the January, 1931, issue of this *Journal*) have been carried out. With a knowledge of yields and botanical composition at intervals during the two seasons an analysis of the herbage produced by the different watering systems has been possible, and a system evolved for the presentation of the data so obtained in graphical form.

Tables 2A and 2B show the yields of dry matter obtained from each mowing of the different plots for the two years of the experiment. For comparison, the total produce obtained to the end of June in each year is given. It will be seen that all the plots yielded more in the 1930-31 season than in 1929-30. In part this might be accounted for by the fact that the mowing was not commenced till 6th October, 1929, when the grass had made considerable growth. It was followed by a cut on 2nd November, 1929, but, in the 1930-31 season, by the 5th November, 1930, four cuts had been taken off. In addition, seasonal conditions during 1930-31 were more favorable to sustained high production than they were in 1929-30.

Any interpretation of the results must be qualified by the fact that besides the variations in yields the botanical composition of the herbage on every bay was different, and the distribution of the production throughout the year was very different. Soil conditions were fairly uniform throughout, manurial treatment was the same for all plots, and the variable factors governing the production, the quality, and the distribution of the produce were seasonal conditions, moisture available in the form of rain plus irrigation water, incidence of the rain (the proximity of irrigations to rainfall) and the botanical composition of the herbage. These factors are interrelated, and the various aspects must be kept in mind when conclusions are being drawn.

TABLE I.—SCHEDULE OF WATERINGS—RATE AND FREQUENCY OF WATERING TESTS, 1929-30.

Watering Period.	Bay 1.	Bay 2.	Bay 3.	Bay 4.	Bay 6.	Bay 7.	Bay 8.	Bay 9.
14 October, 1929	..	..	..					..
15 „ ..	3″							3″
16 „ ..	..	4″						..
17 „ ..	..	..	5″	6″	6″	6″	6″	..
8 November..	..	..	..	..	..	..	..	
9 „ ..	..	..	..	..	..	..	..	3″
12 „ ..					..	..	..	..
13 „ ..	3″				..	..	..	..
14 „ ..	..				..	..	..	..
15 „ ..	..	4″			..	..	..	..
16 „ ..	..	..	5″	6″	..	..	..	..
28 „ ..	..	..	..	..	..	..	..	..
29 „ ..	..	..	..	..			..	
30 „ ..	..	..	..	..			..	3″
1 December ..	..	..	..	..			..	..
2 „ ..	..	..	..	..	6″	6″	..	..
9 „ ..	..	..	..		..	..	..	..
10 „ ..	3″				..	..		..
11 „ ..	..				..	..		..
12 „ ..	..	4″			..	..		..
13 „ ..	..	..	5″	6″	..	..	6″	..
24 „ ..	..	..	..	..	..	..	..	3″
8 January, 1930	..	..					..	..
9 „ ..	3″						..	
10 „ ..	..	4″					..	3″
11 „ ..	..	..	5″	6″	6″	6″	..	..
30 „ ..	..	..	..	..	..	..	..	
31 „ ..	..	..	..	..	..	..	..	3″
3 February ..	3″					..		..
4 „ ..	..	4″				..		..
5 „ ..	..	..				..		..
6 „ ..	..	..	5″	6″	6″	..	6″	..
4 March ..	..	..	..				..	..
5 „ ..	3″						..	
6 „ ..	..						..	3″
7 „ ..	..	4″					..	..
8 „ ..	..	..	5″	6″	6″	6″	..	..
18 „ ..	..	..	..	..	..	..	..	
19 „ ..	..	..	..	..	..	..	..	3″

(The brackets show the time taken to get the required amount of water into the ground.)

The first consideration is total yield of herbage, and it is important to note that the highest yield was obtained by the use of 2 feet of irrigation water. In previous tests at Werribee (see *Journal of Agriculture,* Vol. XXI., No. 8) this amount was established as the best quantity for lucerne also, and the significance of this finding is that in our irrigation systems the water requirements for pasture culture should be no greater than for lucerne. The regular supply of water to the pasture during the summer period is another matter, and its influence will be discussed later.

The influence of varying quantities of water on total yield may be considered first, and in Table 3 there is an extract showing the yields obtained when six waterings are given to each plot in the season, but the quantity applied at each watering varies from 3 inches to 6 inches. Compared with the yield from rainfall alone, the addition of 18 inches of water has produced a large increase in yield; 24 inches gave a further increase and the maximum yield for the whole series. One point of practical importance arising from these results is that in the utilization of the water-right on an irrigated farm it is more economical to apply moderate quantities of water from 18 to 24 inches per annum than it is to use heavier waterings on a smaller area.

To illustrate the efficiency of the various amounts of water, the water-cost of the herbage under the systems of irrigation is shown in terms of the quantity of water which produced 100 lb. of herbage, and the same information is given also by showing the average production per inch of water. Rainfall alone was

TABLE 2A.—YIELDS OF DRY MATTER IN POUNDS FROM SECTIONS 2, 3, AND 4 OF RATE AND FREQUENCY OF WATERING TESTS. SEASON 1929-30.

Date of Cut .. Treatment.	6th Oct.	2nd Nov.	24th Nov.	19th Dec.	6th Jan.	28th Jan.	17th Feb.	10th March.	11th April.	23rd June.	Total
6 waterings of 3″ ..	84·76	75·24	34·17	49·07	45·84	38·53	44·00	58·91	32·55	41·30	504·4
6 ,, 4″ ..	101·72	136·71	55·49	68·85	63·75	48·29	60·58	64·70	41·33	48·80	690·2
6 ,, 5″ ..	110·80	117·52	54·15	61·05	59·56	37·95	60·29	65·01	34·10	54·90	655·3
6 ,, 6″ ..	123·90	141·46	54·45	58·63	64·25	38·20	52·20	70·50	37·64	43·20	684·4
No irrigation ..	67·80	28·37	17·70	14·40	18·44	7·60	..	18·42	6·47	36·70	218·0
5 waterings of 6″ ..	68·80	113·35	51·34	43·90	25·12	35·68	46·16	65·60	39·77	53·80	543·5
4 ,, 6″ ..	123·80	115·69	49·76	40·89	25·68	30·48	7·10	29·58	34·36	72·90	530·2
3 ,, 6″ ..	76·80	106·82	50·81	32·70	35·62	18·00	23·03	27·05	10·99	50·10	431·9
8 ,, 3″ ..	132·80	90·08	54·00	45·40	47·46	35·10	41·00	52·93	67·35	58·10	624·2
Number of days between cuts	..	27	22	25	18	22	20	21	32	73	..

TABLE 2B.—YIELDS OF DRY MATTER IN POUNDS FROM SECTIONS 2, 3, AND 4 OF RATE AND FREQUENCY OF WATERING TESTS. SEASON 1930-31.

Date of Cut .. Treatment.	28th Aug.	16th Sept.	17th Oct.	5th Nov.	29th Nov.	29th Dec.	22nd Jan.	13th Feb.	11th Mar.	4th April.	12th May.	27th June.	Total.
6 waterings of 3″ ..	68·8	38·5	106·0	64·1	55·4	83·3	73·0	52·5	49·1	58·8	52·9	25·0	727·4
6 ,, 4″ ..	90·4	50·7	139·9	66·7	82·0	100·8	82·5	58·1	53·0	59·6	42·3	16·6	842·6
6 ,, 5″ ..	95·2	51·9	153·2	67·5	54·4	93·2	78·6	58·0	58·0	71·1	41·8	17·4	840·3
6 ,, 6″ ..	95·5	50·8	111·4	68·4	49·5	105·1	85·3	57·0	51·8	70·8	44·8	16·8	807·2
No irrigation ..	79·0	22·5	43·0	21·9	9·1	20·8	11·6	..	11·5	20·6	32·5	26·5	299·0
5 waterings of 6″ ..	101·1	48·7	108·2	66·9	61·5	83·9	73·5	21·8	47·3	85·5	49·1	28·9	776·4
4 ,, 6″ ..	111·6	49·3	152·8	44·5	18·0	75·8	17·6	15·3	59·0	97·1	82·3	35·0	758·3
3 ,, 6″ ..	116·3	51·0	48·1	45·3	106·1	37·9	47·5	16·6	30·8	95·0	81·1	43·7	719·4
8 ,, 3″ ..	92·6	54·7	108·0	54·2	119·9	81·1	57·8	50·8	53·0	64·0	42·9	21·3	800·3
Number of days between cuts	66	19	31	19	24	30	24	22	26	24	38	46	..

TABLE 3.—SHOWING THE EFFECT OF VARYING RATES OF WATERING ON YIELD OF HERBAGE AND ON EFFICIENCY OF THE WATER APPLIED.

Treatment.	Season 1929–30.				Season 1930–31.			
	Water Available (Rain + Irrigation).	Yield of Herbage (80 per cent. Moisture) per plot.	Quantity of Water Used to Produce 100 lb. of Herbage.	Amount of Herbage produced per plot per inch of Water Used.	Water Available (Rain + Irrigation).	Yield of Herbage (80 per cent. Moisture) per plot.	Quantity of Water Used to produce 100 lb. of Herbage.	Amount of Herbage produced per plot per inch of Water Used.
	inches.	lb.	inches.	lb.	inches.	lb.	inches.	lb.
No irrigation ..	20·22	1090–0	1·85	53·9	25·09	1495·0	1·68	59·6
6 waterings of 3″ ..	38·22	2522·0	1·51	66·0	43·09	3637·0	1·18	84·4
6 „ 4″ ..	44·22	3451·0	1·28	78·0	49·09	4213·0	1·16	85·8
6 „ 5″ ..	50·22	3276·0	1·53	65·2	55·09	4201·5	1·31	76·3
6 „ 6″ ..	56·22	3422·0	1·61	60·8	61·09	4036·0	1·51	66·2

the least efficient, but the return per inch of rain was greater in 1930-31, when 25.09 inches was recorded than it was in 1929-30 when 20.22 inches of rain fell. The value of the extra rain was reflected in the greater efficiency of the six waterings of 3 inches in the second season.

In Table 4 are shown the results from four plots which receive from 18 to 36 inches of water in the season. In this case the plots received 6 inches at each watering, but the number of waterings was varied. In this particular series the plot receiving 36 inches in six waterings gave the highest yields in both seasons, but having regard to the water-cost of the produce, the six waterings of 6 inches were most efficient in 1929-30, and the three of six the most efficient in 1930-31. From season to season there was least variation in the plot receiving six waterings of 6 inches. This shows a wide difference between the two seasons and it is principally explained by the influence of the extra autumn rain in the 1930-31 season. These results emphasize the fact that irrigation is supplemental to rainfall, and fewer irrigations are necessary when rainfall distribution is favorable. The pasture on the plots in these series has a varying seasonal aspect, and its botanical composition must be considered.

The influence of varying rate and frequency of watering on yield is best presented by considering the results of a given quantity of water applied at different frequencies, and Table 5 shows the efficiency of particular quantities applied in varying ways. The value of frequent waterings is indicated, and not less than six waterings during the summer are shown to be desirable. Twenty-four inches of water in the irrigation season has been shown to be the most effective of the whole series of waterings, but it will be seen from Table 5 that its efficiency depends on the way in which it is divided, the value of a 4-inch watering over a 3-inch outweighing the value of two extra waterings in the season.

TABLE 4.—SHOWING THE EFFECT OF VARIATIONS IN WATER SUPPLY ON YIELD OF HERBAGE AND ON THE EFFICIENCY OF THE WATER APPLIED.

Treatment.	Season 1929–30.				Season 1930–31.			
	Water Available (Rain + Irrigation).	Yield of Herbage (80 per cent. Moisture) per Plot.	Quantity of Water used to Produce 100 lb. of Herbage.	Amount of Herbage Produced per Plot per inch of Water Used.	Water Available (Rain + Irrigation).	Yield of Herbage (80 per cent. Moisture) per Plot.	Quantity of Water used to Produce 100 lb. of Herbage.	Amount of Herbage Produced per Plot per inch of Water used.
	in.	lb.	in.	lb.	in.	lb.	in.	lb.
No irrigation ..	20·22	1090·0	1·85	53·9	25·09	1495·0	1·68	59·6
3 waterings of 6″ (18″)	38·22	2195·5	1·77	56·5	43·09	3597·0	1·20	83·5
4 „ 6″ (24″)	44·22	2651·0	1·67	59·9	49·09	3791·0	1·29	77·3
5 „ 6″ (30″)	50·22	2717·5	1·85	54·1	55·09	3882·0	1·42	70·5
6 „ 6″ (36″)	56·22	3422·0	1·61	60·8	61·09	4036·0	1·51	66·2

Showing headland cut before taking off herbage from a section of the rate and frequency of watering tests.

Examination of the recorded yields shows the distribution of the yield through the seasons is affected by the method of using the irrigation water, and to facilitate the study of this phase of the experiment graphs showing the trend of production at successive periods have been drawn. (Diagrams 2A and 2B.) The estimated yields of green herbage (80 per cent. moisture) obtained at each mowing were divided by the number of days between that mowing and the preceding one, and the figures so obtained were plotted on the mid-dates between cuts. It will be understood that the graphs do not purport to show the mean daily production at any definite point, but are intended to show generally the rate of production over limited periods.

Considering first the graph representing growth on the unirrigated plot (Diagram 2A), it will be seen that there is very little production in summer, and most growth takes place in autumn and spring, but production on this plot is a reflex of the amount and distribution of the rain which occurs, and it varies from season to season. The rainfall for successive ten-day periods during the two seasons under review has been totalled, plotted on the mid-date, and the resultant graph smoothed in order to facilitate comparison with the production graphs. It will be seen from this graph that in the latter half of February, 1930, exceptionally heavy rain fell, and this explains the peak of production in the yield graph at the end of February, and beginning of March, 1930. In December of both years good rains fell and active growth resulted. As the rainfall during summer is sporadic production on this plot is sporadic.

Considering all the plots receiving six irrigations in the season and the one receiving

TABLE 5.—SHOWING THE EFFECT OF FREQUENCY OF WATERING ON YIELD OF HERBAGE AND ON THE EFFICIENCY OF THE WATER APPLIED.

Treatment.	Season 1929–30.				Season 1930–31.			
	Water Available (Rain + Irrigation).	Yield of Herbage (80 per cent. Moisture) per Plot.	Quantity of used to Water Produce 100 lb. of Herbage.	Amount of Herbage Produced per Plot per inch of Water used.	Water Available (Rain + Irrigation).	Yield of Herbage (80 per cent. Moisture) per Plot.	Quantity of Water used to Produce 100 lb. of Herbage.	Amount of Herbage Produced per Plot per inch of Water used.
	in.	lb.	in.	lb.	in.	lb.	in.	lb.
18″ 3 waterings of 6″	38·22	2195·5	1·77	56·5	43·09	3597·0	1·20	83·5
18″ 6 „ 3″	38·22	2522·0	1·51	66·0	43·09	3637·0	1·18	84·4
24″ 4 waterings of 6″	44·22	2651·0	1·67	59·9	49·09	3791·0	1·29	77·3
24″ 6 „ 4″	44·22	3451·0	1·28	78·0	49·09	4213·0	1·16	85·8
24″ 8 „ 3″	44·22	3121·0	1·42	70·6	49·09	4001·5	1·23	81·6
30″ 5 waterings of 6″	50·22	2717·5	1·85	54·1	55·09	3882·0	1·42	70·5
30″ 6 „ 5″	50·22	3276·0	1·53	65·2	55·09	4201·5	1·31	76·3

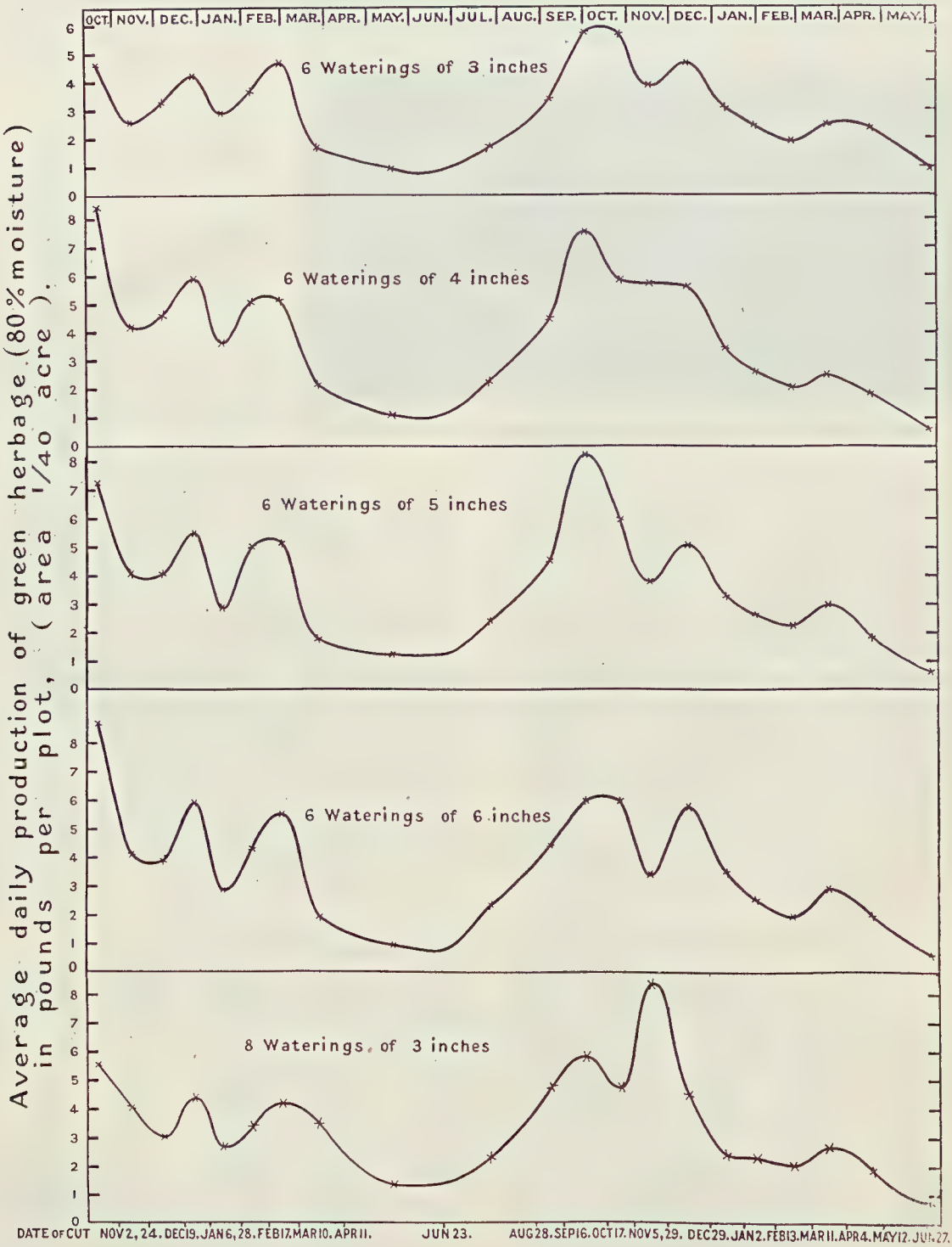

OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY. JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY.
6 Waterings of 3 inches
6 Waterings of 4 inches
6 Waterings of 5 inches
6 Waterings of 6 inches
8 Waterings of 3 inches
Average daily production of green herbage (80% moisture) in pounds per plot, (area 1/40 acre).
DATE OF CUT NOV 2, 24. DEC 19. JAN 6, 28. FEB 17. MAR 10. APR 11. JUN 23. AUG 28. SEP 16. OCT 17. NOV 5, 29. DEC 29. JAN 2. FEB 13. MAR 11. APR 4. MAY 12. JUN 27.

Diagram 2a.—Graphs showing average daily production of green herbage.

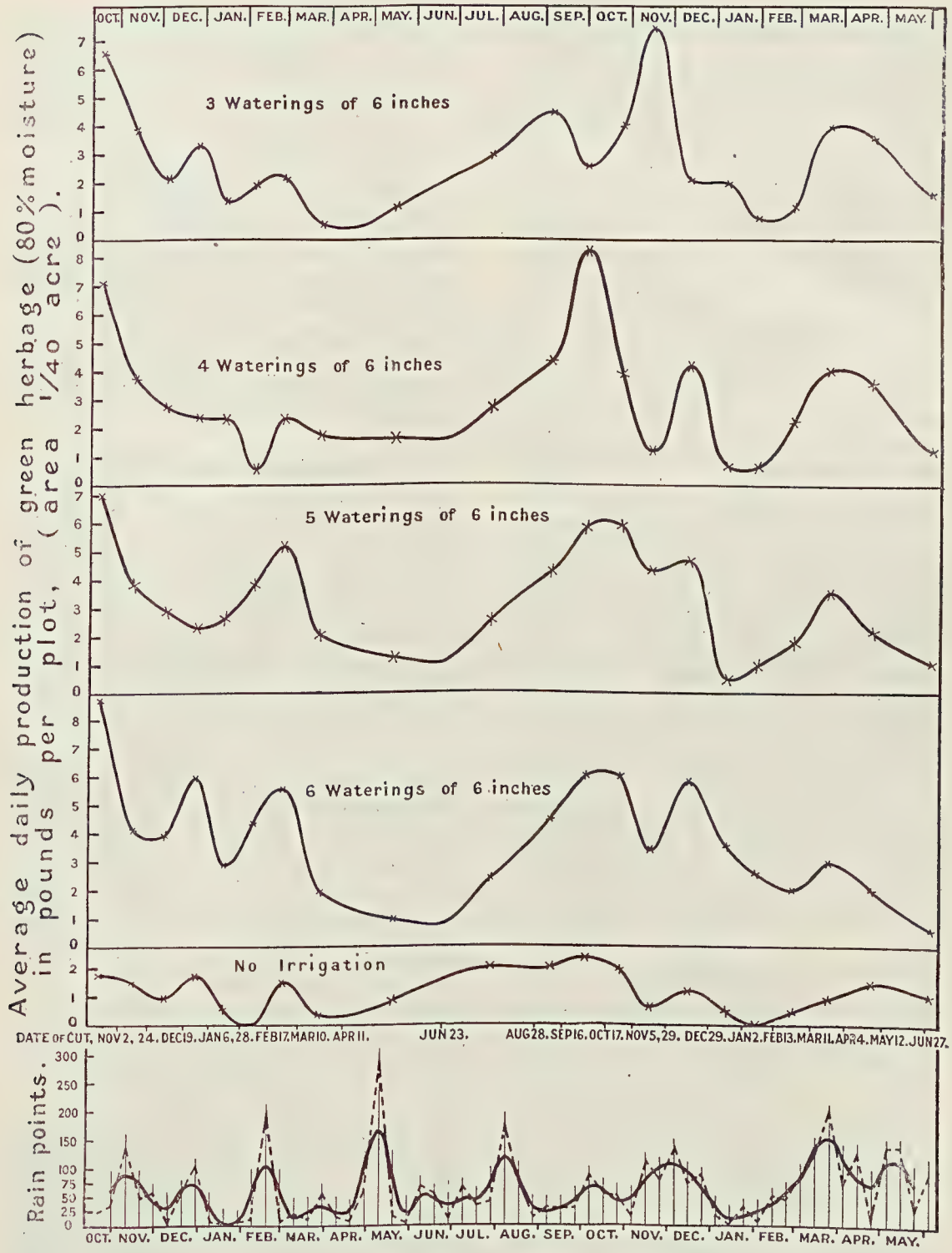

OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY. JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY.
Average daily production of green herbage (80% moisture) in pounds per plot, (area 1/40 acre).
3 Waterings of 6 inches
4 Waterings of 6 inches
5 Waterings of 6 inches
6 Waterings of 6 inches
No Irrigation
DATE OF CUT. NOV 2, 24. DEC 19. JAN 6, 28. FEB 17. MAR 10. APR 11. JUN 23. AUG 28. SEP 16. OCT 17. NOV 5, 29. DEC 29. JAN 2. FEB 13. MAR 11. APR 4. MAY 12. JUN 27.
Rain points.
OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY. JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY.

Diagram 2b.—Graphs showing average daily production of green herbage and rainfall distribution.

eight, a similar trend of production throughout the season and a similar influence of rainy periods are apparent for the five plots, but the amount of production at particular times varies on the different plots. The evidence from both seasons indicates that production of an irrigated pasture seems to be characterized by three peak periods—one in spring, one in midsummer, and one in autumn, the exact times of occurrence of these being varied by the times of occurrence of the seasonal rains.

The plots receiving fewer than six waterings, viz., three of 6 inches, four of 6 inches, and five of 6 inches, differ from one another and from the plot watered six times. At first sight quite dissimilar trends of production are shown on the graphs, but a close examination shows that what might have been a "normal" trend of production was distorted by the periods of dryness which inevitably occurred when the irrigations were infrequent and the rainfall did not meet the moisture deficiencies so produced.

As might be expected, the periodicity of growth of the plot watered five times is most like that on the plots watered six times, and on these three plots during midsummer production does not reach the high level attained on the frequently watered plots, which have a sustained high production during midsummer. In fact, the plot receiving eight waterings of 3 inches reaches a higher production level in summer than in spring, due to the fact that at this period irrigations were most frequent on this plot.

It is interesting to note here that the dominant species on the regularly watered plots (i.e., those receiving six waterings and more), with the exception of the plot receiving only 18 inches, is white clover. Even in this last plot it is a constituent of major importance. White clover is dependent on regular summer waterings for continued existence, and intermittent watering at wide intervals is not favorable to it, particularly in a dry summer.

In the infrequently watered plots subterranean clover constitutes a much larger proportion of the total herbage than it does in the regularly watered plots—indeed on the plots receiving only three and four waterings it becomes the dominant species. This means that the herbage on the two sets of plots, the frequently watered and the infrequently watered, have two different seasonal aspects. The predominance of subterranean clover means increased autumn and winter growth, and these plots showed a much better production rate during the period from autumn to spring with their peak period in spring, but this increased growth in the cooler parts of the year did not compensate for the reduced growth in summer.

As previously shown in Tables 3, 4, and 5, the efficiency of the water available to each plot was increased in the second season, but to a much greater extent in the case of the infrequently watered plots than it was on the regularly watered plots, although six waterings of 3 inches, shown to be inadequate for maximum production, was much more effective in 1930-31. This fact is illustrated very well in the graphs when the distribution of the yield and the production levels for the two seasons are compared.

Botanical Composition.

Total yield, and the seasonal distribution of yield, are the factors of paramount importance in pasture production. They are, however, so intimately associated with the reactions of the constituent species of the pasture to the varying conditions artificially created by the use of varying watering practice that an analysis of the total herbage into its constituent species is desirable for a complete understanding of the yield results which have been presented in the foregoing tables.

To obtain the requisite data for such an analysis, sections 2, 3, and 4 of the various plots were chosen as convenient media for periodical botanical surveys during the two seasons of the test. In order to ensure a satisfactory degree of accuracy in these surveys, a test was made on 18th July, 1930, by taking 50 estimation samples on a section of one of the plots according to the "percentage estimation" method previously described in this *Journal* (January, 1931). This particular section was chosen as one in which a good representation of all major species was apparent, and the test was carried out at a period of the year when it was felt that maximum errors would be encountered. The results of the test are set out in Table 6.

In this table sufficient data are presented to allow of an analysis of the more important factors which govern the accuracy of a botanical survey in so far as a comparison of the relative percentages of any one species occurring on any two plots of *similar* botanical

composition is concerned. It is seen that in the first place the standard error of 30 estimation samples for a particular species is largely determined by the percentage of the total herbage which that species comprises. Thus for—

Total legumes, 67.4 per cent., S.E.m, is 2.9 per cent.
White clover, 36.2 per cent., S.E.m, is 11.7 per cent.
Sub. clover, 30.3 per cent., S.E.m, is 14.0 per cent.
Rye-grass, 5.1 per cent., S.E.m, is 18.8 per cent.

But another factor of importance is the maximum range of the percentages of the species which may be met with over the whole of the samples estimated, e.g., in the case of the subterranean clover and the total grasses, the percentage of the total herbage was almost the same, viz., 30.3 per cent. subterranean clover and 29.2 per cent. total grasses, but the standard error of the mean of 30 estimation samples was only 7.0 per cent. for total grasses as compared with 14.0 per cent. for subterranean clover. The reason for this was that the percentage of subterranean clover in any random sample might be anything from 0 per cent. to 72 per cent., while in the case of the total grasses it varied only between 0 per cent. and 50 per cent. Further, while grass was absent from the samples in only 2 per cent. of cases, subterranean clover was absent in 6 per cent. of cases.

From the above test we may conclude that a range of 0 to 75 per cent. is the maximum likely to be encountered, and that in general the errors of sampling of species so distributed represent those errors in their greatest magnitude. Table 7, prepared from the data in Table 6, shows the approximate maximum error of the mean of 30 samples (the largest number which it was convenient to do in the botanical surveys proper) for *any* species for various degrees of importance of that species in the herbage—

Table 7.—Errors of Botanical Survey.

Percentage of Total Herbage.	S.E.m Percentage (30 Samples).	Percentage differences necessary for Significance (for Plots of *similar* Botanical Composition).
%		
6–15	18	25
16–25	16	22
26–35	14	20
36–45	11	15
46–55	8	11
56–65	5	7
66–75	2	3

It was found that the above requirements for the significance of differences in the percentages of the species were satisfied by the majority of the differences shown by the botanical surveys. As a result, it was felt that the survey figures were sufficiently reliable to be accepted without qualification, particularly for the major species.

When an analysis of the productions of the various plots into their respective species productions was attempted by using the survey figures and the yields of the cuts to which they referred as data from which to calculate the amounts in pounds of the various species present, dividing that amount by the number of days since the previous cut, and plotting the resultant figure on the mid-point of the period between the cut and its predecessor, it was evident that for best results a survey should

Table 6.—Test of Accuracy of Botanical Survey.

—	Species.						Bare Space.
	Total Grass.	Total Legumes.	Rye.	Cocks-foot.	White.	Sub. Clover.	
	%	%	%	%	%	%	%
Standard error for 30 samples	7·0	2·9	18·8	10·1	11·7	14·0	13·0
Percentage of total herbage	29·2	67·4	5·1	23·8	36·2	30·3	9·6
Percentage occurrence	98	100	88	88	92	94	90
Total range of estimations	0–50	51–95	0–18	0–45	0–76	0–72	0–35
Probable standard error of differences shown by two plots with very similar composition ..	9·9	4·1	26·6	14·3	16·5	19·8	18·4
To be significant, differences should be of the order of	19·8	8·2	53·2	28·6	33·0	39·6	36·8

have been made before every cut. Time had not permitted of this in the early part of the trials, but later "flying surveys" were made to supplement the complete surveys. As for the cuts for which no survey figures were available, this difficulty was overcome by the use of a method of interpolation based on the observed fact that any changes in botanical composition in the plots were gradual and regular in their progress, i.e., no sudden fluctuations of large degree occurred within a short period at any time in the intervals between the surveys.

The problem was as follows:—Given the yields, the percentages of the various species, and the time of growth for two cuts, the *probable* values of the yields and percentages of species for cuts intermediate to the two known cuts were arrived at by means of straight-line graphs, with due regard to the times of growth of the intermediate cuts. The probable amounts of the species present at those intermediate cuts was thus arrived at, and then corrected for the actual yields as determined by mowing. All quantities were reduced to the same standard by dividing by the number of days between successive cuts and the values so arrived at, both real and interpolated, were plotted on the mid-dates of the growth periods to which they referred. The linking up of these points furnished graphs (Diagrams 3A and 3B), for all the important species, which were comparable with the "total production" graphs already referred to. These graphs of the "species productions" throw considerable light on the reasons for the variations in the characters of the total production graphs, and also illustrate clearly the varying seasonal periodicities of the species.

Rye-grass, although a comparatively unimportant component of the herbage of all plots, is seen to possess a marked tendency towards maximum production in spring. After the removal by the mower of the seeding heads which appeared at this stage, growth was not rapid, and there was no evidence of response to applications of irrigation water during the summer. Cocksfoot, which is an important constituent, particularly on the less-heavily and less-frequently watered plots, similarly shows a marked activity in spring, but has the added advantage of being responsive to summer waterings, as a result of which it again reaches a peak in midsummer, thereafter gradually falling away to a mini-

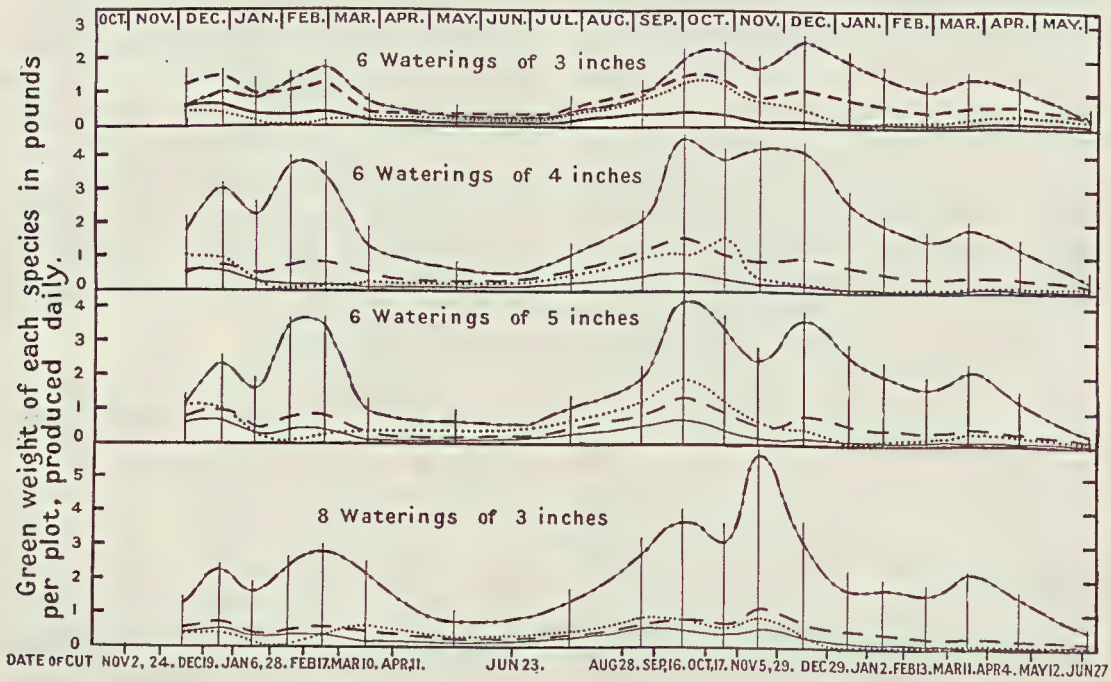

OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY. JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY.
6 Waterings of 3 inches
6 Waterings of 4 inches
6 Waterings of 5 inches
8 Waterings of 3 inches
Green weight of each species in pounds per plot, produced daily.
DATE OF CUT NOV 2, 24. DEC 19. JAN 6, 28. FEB 17. MAR 10. APR 11. JUN 23. AUG 28. SEP 16. OCT 17. NOV 5, 29. DEC 29. JAN 2. FEB 13. MAR 11. APR 4. MAY 12. JUN 27

Diagram 3a.—Green weight of each species produced from various waterings. For key see diagram 3b.

mum in midwinter. Another important point in its favour is its ability to stand up to the conditions of close and frequent mowing which were a feature of the test: the type of rye-grass present was apparently seriously affected by the mowing, and lost ground to a large extent in the second season. On all except the unirrigated plot, no other grasses present are of sufficient importance to merit consideration.

Of all the species represented in the pasture, white clover, under suitable watering conditions, proved itself the heaviest and most consistent yielder, being active in spring, particularly active in summer and also growing well in autumn. In the graphs of frequently watered plots (Diagram 2B), the similarity in regard to the incidence of the peaks of production is striking, and is directly due to three well-defined active-growth periods of the white clover which is the dominant species on all except the six waterings of 3 inches. While the incidence of autumn rainfall appears to be the factor determining the occurrence of the autumn peak of white clover on these plots, the incidence of the spring and summer peaks is not greatly influenced by seasonal conditions, although their magnitude may be greatly affected. This statement also holds for the infrequently watered plots with the exception of the three waterings of 6 inches, in which the spring and summer peaks, while maintaining their positions relative to each other, are somewhat later in 1930-31; this also occurs in the eight waterings of 3 inches.

Subterranean clover, which is the dominant species on those plots on which the watering system is inadequate for white clover dominance, shows a relatively high rate of winter production, and in early spring growth is at a maximum. Following the spring activity, its vigour decreases gradually with adequate waterings until at midsummer it is practically non-existent except in so far as the new crop of seedlings may be conspicuous. During autumn seedlings make good growth and re-establish the subterranean clover as an important element in the pasture. The question of the factors governing the struggle for dominance between white and subterranean clovers under irrigation will be discussed later.

Under natural rainfall conditions at Werribee, lucerne is the only important constituent of the original seeding mixture which has survived the harsh conditions imposed by the often lengthy dry periods of summer. Lucerne has a production peak in summer, the exact occurrence of which is dependent mainly on the incidence of favorable rainfall.

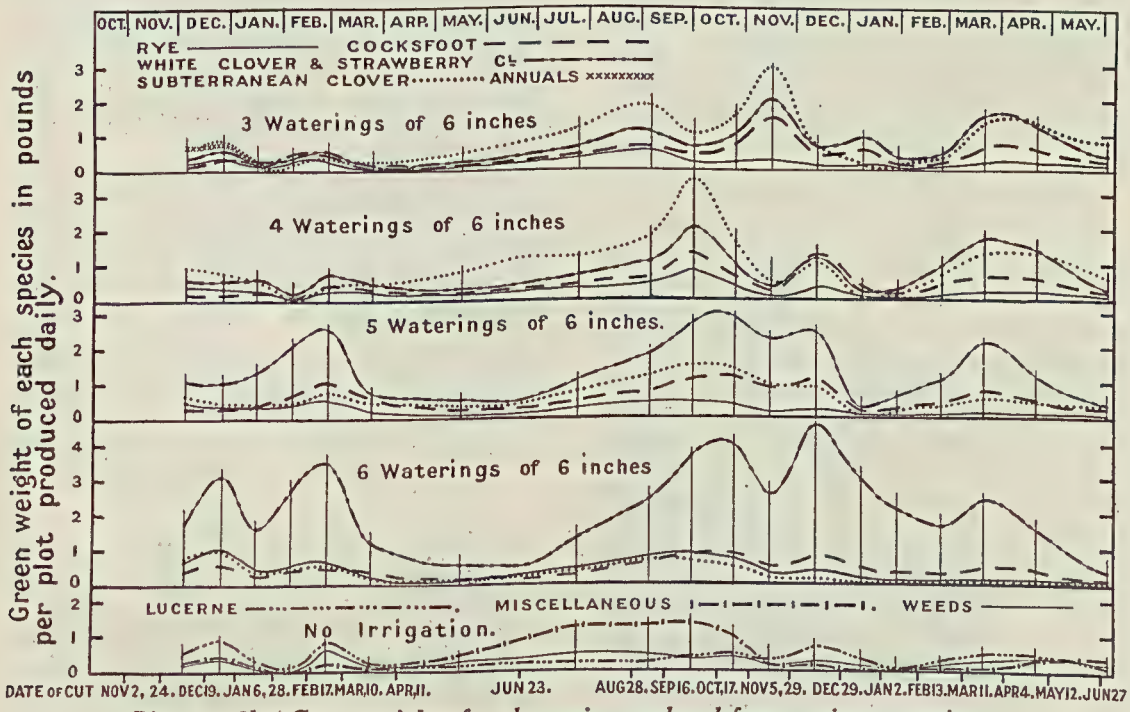

OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY. JUN. JUL. AUG. SEP. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY.
RYE
COCKSFOOT
WHITE CLOVER & STRAWBERRY CL
SUBTERRANEAN CLOVER
ANNUALS
3 Waterings of 6 inches
4 Waterings of 6 inches
5 Waterings of 6 inches.
6 Waterings of 6 inches
LUCERNE
MISCELLANEOUS WEEDS
No Irrigation.
Green weight of each species in pounds per plot produced daily.
DATE OF CUT NOV 2, 24. DEC 19. JAN 6, 28. FEB 17. MAR 10. APR 11. JUN 23. AUG 28. SEP 16. OCT 17. NOV 5, 29. DEC 29. JAN 2. FEB 13. MAR 11. APR 4. MAY 12. JUN 27

Diagram 3b.—Green weight of each species produced from various waterings.

Other species capable of persisting under dry conditions have invaded the unirrigated plot, and furnish the major proportion of the yield obtained from it. These are, notably, weeds such as hogweed (*Polygonum aviculare*), cape-weed (*Cryptostemma calandulacea*), keeled goosefoot (*Chenopodium carinatum*), marshmallow (*Malva rotundifolia*), sowthistle (*Sonchus oleraceus*), peppercress (*Lepidium virginicum*), and miscellaneous weedy grasses such as barley-grass (*Hordeum murinum*), brome fescue (*Festuca bromoides*), and weedy brome-grasses (*B. mollis, B. sterilis*), with an occasional plant of wallaby grass (*Danthonia* sp). It is not intended to touch on the periodicities of all the volunteer species which occur on this plot, but the general periodicities of the two classes, weeds and miscellaneous weedy grasses, are clearly outlined in the graph, and are shown to be entirely dependent on the incidence of favorable rainfall. During the 1929-30 season lucerne was the dominant species, weeds and miscellaneous grasses being of equal and secondary importance, until the heavy autumn rains caused a great activity of growth of weeds, which then assumed an almost equal importance with lucerne. In the winter the miscellaneous grasses became dominant, retaining this position until early summer, 1930-31, when lucerne again re-asserted itself. The lateness of the autumn rains in the second season delayed the appearance of the autumn peak of production of the lucerne and weeds, but the sequence of changes in dominance was the same as in 1929-30.

In the foregoing paragraphs the periodicities of the various species have been discussed, and the similarity of incidence of the high-production peaks of the species under all watering systems has been noted. The relative importance of these peaks varies, however, with the watering systems to which the species are subjected, and it is now proposed to discuss this phase of the tests, with first a special reference to the conditions which appear essential to the dominance of the various species. In making inter-plot comparisons in regard to the influence of varying water supply on the productivity of any one species, the use of the percentage values obtained by means of the botanical surveys would be quite erroneous, as it is conceivable that a low average percentage of rye-grass on a high-yielding plot might indicate better growth conditions for that species than a high average

Steel quadrant used in making botanical surveys.

percentage of it present on a low-yielding plot. On the other hand, however, when estimating the changes in the balance of species brought about by variation of watering practice, the use of the average percentages of the species present is logical.

The most important species balance for consideration is, necessarily, the balance of grasses and legumes. In order to obtain comparisons of this balance on the various plots, the percentages of total grass have been averaged. (Table 7A.)

TABLE 7A.—SHOWING THE AVERAGE PERCENTAGES OF TOTAL GRASSES ON THE VARIOUS PLOTS.

Waterings.	Average percentage of Total Grasses.
6 of 3″	34·6
6 ,, 4″	23·6
6 ,, 5″	23·8
6 ,, 6″	25·3
5 ,, 6″	29·5
4 ,, 6″	28·1
3 ,, 6″	25·6
8 ,, 3″	22·8

Weighing green clippings and sampling for chemical analysis.

From this table it is evident that on the six-watering plots the 4-inch waterings, compared with the 3-inch waterings, have caused a decided change in the balance of grass to legumes in favour of the latter, but waterings above 4 inches have not caused any further material alteration. In the infrequently watered plots the variation, although tending to demonstrate an increased importance of the total grasses with increase in the frequency of watering, has not been great. In contrast to this, the most frequently watered plot (the eight waterings of 3 inches) shows the total grasses at their lowest value for the series.

TABLE 8.—SHOWING THE AVERAGE PERCENTAGES OF RYE-GRASS AND COCKSFOOT ON THE VARIOUS PLOTS.

Waterings.	Average per cent. Rye-grass.	Average per cent. Cocksfoot.	Ratio of Cocksfoot to Rye.
6 of 3″ ..	7·9	26·7	3·4
6 „ 4″ ..	5·1	18·5	3·6
6 „ 5″ ..	6·4	17·4	2·7
6 „ 6″ ..	10·9	14·4	1·3
5 „ 6″ ..	7·8	21·7	2·8
4 „ 6″ ..	9·4	18·7	2·0
3 „ 6″ ..	8·9	16·7	1·9
8 „ 3″ ..	7·5	15·3	2·0

Considering next the relationship between rye-grass and cocksfoot shown in Table 8, it will be seen that the balance of cocksfoot to rye is materially altered by waterings in excess of 4 inches, the lowest ratio being reached with six waterings of 6 inches. On the infrequently watered plots, and on the eight waterings of 3 inches, the ratio is similarly reduced, excepting the five of 6 inches, which is identical with the six of 5 inches.

TABLE 9.—SHOWING THE AVERAGE PERCENTAGES OF WHITE CLOVER AND SUBTERRANEAN CLOVER ON THE VARIOUS PLOTS.

Waterings.	Average per cent. White Clover.	Average per cent. Subterranean Clover.	Ratio of White to Subterranean Clover.
6 of 3″ ..	38·2	14·2	2·7
6 „ 4″ ..	60·6	10·9	5·6
6 „ 5″ ..	55·9	16·6	3·4
6 „ 6″ ..	64·5	8·8	7·3
5 „ 6″ ..	45·4	19·2	2·4
4 „ 6″ ..	27·7	31·4	0·9
3 „ 6″ ..	24·7	33·1	0·8
8 „ 3″ ..	62·5	11·0	5·7

Lastly, in the case of white and subterranean clovers, the average percentages of which are set out in Table 9, if we exclude the six waterings of 5 inches plot, which for some obscure reason shows a percentage of subterranean clover in excess of that which might be expected in view of the tendencies shown by the other plots, increases in both the rate and the frequency of watering are accompanied by a rapid increase in the dominance of white clover as compared with subterranean clover, the maximum being reached with six waterings of 6 inches. Further, it is seen that frequency of watering exercises a much

greater influence in this direction than does rate of watering, since in all the six-watering plots, in the five waterings of 6 inches, and in the eight waterings of 3 inches the dominance of white clover is many times greater than in the plots receiving only three and four waterings. When the frequency of watering rises above four per season, therefore, the subterranean clover ceases to be a strong competitor with the white clover for dominance.

Before dismissing the percentages obtained by the surveys, it is interesting to examine them from the stand-point of the average amount of bare space present on the various plots, a summary of which is shown in Table 10. The importance of bare space in a pasture is readily understood when it is remembered that the inability of all the originally sown species, except lucerne, to survive under the dry conditions of the unirrigated plot created a large amount of bare space into which the entry of inferior plants, weeds, and annual grasses was unhindered; once established, these plants assumed dominance for six months in each year. While the situation is not in any way as bad as this on irrigated pastures, the inevitable accompaniment of an increase in the bare space, if permanent, is an increase in the importance of these casual and inferior pasture plants.

Table 10.—Showing the Average Percentages of Bare Space on the Various Plots.

Waterings.	Average per cent. Bare Space.
6 of 3″	15·4
6 „ 4″	5·3
6 „ 5″	6·1
6 „ 6″	5·6
5 „ 6″	13·3
4 „ 6″	17·2
3 „ 6″	15·8
8 „ 3″	7·6

Consequently, it is important to note that with frequent waterings of 4 inches and over the danger of this development is minimized. It may be assumed also that if it were not for the inclusion in the seeding mixture of subterranean clover, which, though greatly superior to weeds and weedy grasses as a pasture plant, shares with them a capacity for colonizing such bare areas as develop under conditions of watering inadequate for the best development of white clover, the proportion of such weeds and grasses would have been much more conspicuous on the infrequently watered plots, and/or the aggregate area of bare and unproductive ground on those plots would have been greater. In addition to allowing the entry of undesirables, bare spaces tend to increase the water-cost of the herbage by allowing greater losses by evaporation. This is particularly true in districts where, under the hot dry conditions of summer, the soil surface tends to open up, and the water losses are greatly increased as the result of the formation of deep soil cracks.

Summarizing the information presented in Tables 7, 8, 9, and 10, we see that—

(1) With frequent waterings the maximum alteration in the total grass—total legumes balance is effected by raising the watering from 3 inches to 4 inches or more;

(2) the cocksfoot—rye-grass ratio is decreased by frequent waterings in excess of 4 inches;

(3) a satisfactory dominance of white clover over subterranean clover is obtained by frequent waterings of 4 inches; and

(4) the percentage of bare space is reduced to a minimum with frequent waterings of 4 inches.

In view of the above, we may conclude that, from the point of view of the species balances, the plot receiving six waterings of 4 inches represents a very satisfactory equilibrium.

The other phase of the influence of watering method on species, viz., the influence of the watering system on the productive capacity of a species when subjected to the competition of associated species, is best examined, as previously indicated, by a consideration of the average rates of production of the species on the various plots (Table 11). Since the tests were commenced somewhat late in 1929, only the 1930-31 season figures are given. According to this table, the productivity of rye-grass is stimulated by increased rates of watering, although it is only in the case of the plot receiving six waterings of 6 inches that the increase is large. Cocksfoot, on the other hand, is not favoured by the heavier waterings. Whatever the causes of this lessened production of the cocksfoot, the important fact remains that until waterings in excess of 4 inches are applied this decrease is not great, which again forces one to the conclusion that six waterings of 4 inches preserve an excellent balance of production and per-

sistency in so far as cocksfoot is concerned. Since cocksfoot appears from these tests to be a grass which stands up well to the rigorous conditions imposed by the lawn mowing method of harvesting—the mechanical method nearest approaching the conditions of hard grazing—whereas the rye-grass tends to decrease under such treatment, it is important to adopt that watering method which does not prematurely exhaust the productivity of the cocksfoot.

TABLE 11.—SHOWING THE AVERAGE RATES OF PRODUCTION OF SPECIES UNDER VARIOUS WATERING TREATMENTS DURING 1930-31.

Waterings.	Average Rate of Production. (lb. per plot per day.)			
	Rye-grass.	Cocksfoot.	White Clover.	Sub-terranean Clover.
6 of 3″ ..	·17	·80	1·42	·51
6 „ 4″ ..	·17	·73	2·44	·42
6 „ 5″ ..	·20	·59	2·20	·57
6 „ 6″ ..	·33	·48	2·46	·21
5 „ 6″ ..	·17	·64	1·57	·70
4 „ 6″ ..	·25	·57	·93	1·16
3 „ 6″ ..	·21	·55	·93	1·14
8 „ 3″ ..	·24	·51	2·39	·35

If we exclude the six waterings of 5 inches plot, which has been previously pointed out to be somewhat anomalous, it is seen that the productiveness of white clover, the most important irrigated pasture species, may be increased from one and a half to two and a half times by raising the frequency of watering from three of four per season to five, six, or eight; and, further, that the result obtained by giving 2 feet of water in six waterings of 4 inches is as good as that obtained by giving 3 feet of water in six waterings of 6 inches.

Subterranean clover in this test reached maximum productivity only in the absence of competition from the white clover, which on the adequately watered plots prevented the encroachment of the former even in winter, a period when seasonal conditions favoured the subterranean clover. It is on the basis of this successful competition of the white clover that the decrease in the productiveness of the subterranean clover with increase in both rate and frequency of watering is explained. With 6-inch waterings the turning point in the struggle for dominance is seen to be when the frequency of watering is increased from four per season to five.

Summarizing the information available in regard to the influence of watering methods on species productivity, we have the following:—

(1) Rye-grass production is increased by waterings in excess of 4 inches, if frequent.

(2) Cocksfoot in a mixture is slightly handicapped by six waterings of 4 inches in comparison with six waterings of 3 inches, but a material reduction in productivity follows on any further increase in the rate of watering, and this is undesirable in view of the value of cocksfoot as a nutritious grass capable of persisting under conditions which simulate close hard grazing at frequent intervals.

(3) The productivity of white clover practically reaches a maximum with six waterings of 4 inches.

From the various stand-points of total production, balance of species, and productivity of species, therefore, six waterings of 4 inches would seem to possess decided advantages over all other watering methods tested. However, two other important requirements remain to be satisfied by this method. Of these, the uniformity of production throughout the year will be first considered, after which the question of fodder value of the herbage will be discussed. It will be generally conceded that an ideal pasture would be one which maintained an uniformly high rate of production throughout the year, but unfortunately this ideal, in view of the seasonal periodicities of pasture species and varying seasonal conditions, seems impossible of fulfilment. The next best thing is to determine the conditions under which the nearest approach to this ideal may be obtained. If we can establish a particular watering method as the one from the use of which the least variability in seasonal production accrues, and this system does not cause the total annual production to suffer, that practice is to be recommended in preference to all others.

For comparative purposes it is convenient to divide the annual production into winter and summer production, the latter being inclusive of the growth during spring and autumn. The graphs of total production show that in winter the activity of the pasture, as compared with summer levels, is uniformly low on all plots, although on those plots in which subterranean clover is an important or dominant

element (i.e., the infrequently watered plots) the winter production is highest for the series, especially in the latter part of the winter. The advent of spring is coincident with a great variation in the productivity of the various plots, and the positions of the plots in the yield scale are then, in general, reversed. In Table 12 the maximum and minimum rates of production for the summer period, and the minimum for the winter period are shown, and the percentage variation during the summer period is included. It shows clearly that six waterings of 4 inches, already established as

TABLE 12.—SHOWING VARIATION IN RATE OF PRODUCTION, 1930-31 SEASON.

Waterings.	Rate of Production. (In lb. per plot per day.)			
	Winter Minimum.	Summer Maximum.	Summer Minimum.	Percentage Variation in Summer Period.
6 of 3″ ..	·91	5·70	1·88	203
6 „ 4″ ..	·61	7·51	2·04	268
6 „ 5″ ..	·63	8·22	2·23	268
6 „ 6″ ..	·61	6·00	2·00	200
5 „ 6″ ..	1·04	5·89	·54	990
4 „ 6″ ..	1·26	8·22	·68	1,110
3 „ 6″ ..	1·59	7·42	·77	865
8 „ 3″ ..	·77	8·34	2·04	309

sound practice on the score of total production, has a good uniformity of production throughout spring, summer, and autumn, which outweighs the disadvantage of its low winter yield.

When it is remembered that seasonal rainfall conditions were better during the season than in 1929-30, and tended to improve the yielding ability of the plots receiving the lower rates and frequencies of watering to a higher degree than it did on the remaining plots, the indications are that in a less favorable season the six waterings of 4 inches, in point of uniformity of production, would show up to even greater advantage. It is all a matter of the maintenance of soil moisture conditions suitable for the uninterrupted growth of white clover. In practice these conditions are most economically obtained by frequent waterings of not less than 4 inches. On the infrequently watered plots an extended dry period, with attendant high transpiration and evaporation of moisture, often results not only in the checking of the growth of white clover, but also, in the worst cases, in the death of the leaves and stolons. In addition, the subterranean clover which is responsible for the bulk of their yield is almost completely absent for a period in midsummer. On the frequently watered plots, on the other hand, the regularity of the watering often results in a slight loss of efficiency due to the incidence of heavy rainfall close to the time of irrigation, but, needless to say, this contingency is highly preferable to the former.

As a final consideration, we come to the quality or fodder value of the pasture and the influence of watering method in this direction. The detailed results of the chemical analyses of the different cuts during the 1929-30 season have been tabulated and discussed by the Agricultural Research Chemist (Mr. W. R. Jewell) in a recent issue of this *Journal* (Vol. XXIX., No. 7). On all the plots the feeding value of the herbage was high, and the nutritive ratio narrow, even on the unirrigated plot. On this plot, however, the lucerne content in summer was high, and this probably explains the results obtained. Large variations in feeding value occurred from cut to cut on all the plots, and it has been suggested by Jewell that these variations are due to the proximity of cuts to waterings and/or to heavy rainfall. After excluding the first cut for each plot, made in early October, 1929, the protein percentages for the various cuts were graphed against the total production graphs for the various plots. It was then seen that the protein graphs agreed very well with the latter, the feeding value of the herbage being enhanced during periods of rapid production. Also, during periods when subterranean clover is making rapid growth, particularly on those plots in which it is an important constituent, the feeding value of the herbage is raised. This accounts for the high feeding value of late winter cuts on the infrequently watered plots. On comparison of the graphs of the percentages of protein, silica-free ash, carbohydrate plus fat, and crude fibre, with the graphs showing the rate of production of the various plots, it was seen that *from cut to cut* the following general conclusions may be drawn:—

1. The protein content of the herbage rises as the rate of production increases.
2. The fibre content increases as the rate of production increases.
3. The carbohydrate plus fat content decreases as the rate of production increases.
4. The silica-free ash rises as the rate of production increases.

These generalities hold for cuts made within approximately the same seasonal period, but it must not be inferred that the percentage of protein or any other constituent bears to the rate of production the same mathematical relationship at all seasons. For example, on the "eight waterings of 3 inches" plot the protein percentages and rates of production at the tenth and fourth cuts (1929-30) respectively were—

—	Rate of Production.	Protein Percentage.
4th cut ..	3·04	25·31
10th „ ..	1·33	25·96

Further, for any one cut, the rates of production of the various plots are *not* found to be an important factor governing the fodder value of the herbage, thus at the fifth cut, 1930-21 season, the protein percentages and rate of production figures for the various plots were as shown in Table 13.

Table 13.—Rate of Production of Herbage and Protein Content.

Waterings.	Rate of Production.	Protein Percentage.
6 of 3″ ..	3·84	24·80
6 „ 4″ ..	5·71	24·93
6 „ 5″ ..	3·79	25·55
6 „ 6″ ..	3·46	23·36
5 „ 6″ ..	4·33	24·97
4 „ 6″ ..	1·25	24·90
3 „ 6″ ..	7·42	23·63
8 „ 3″ ..	8·34	25·17

Table 13 gives no indication of a constant relationship between the two factors mentioned. In Table 14 the figures for the rates of production of the white clover and cocksfoot on the various plots is given in comparison with the protein percentages.

From Table 14 it appears that although, as stated, the protein percentage of the herbage from any one plot rises and falls in agreement with the trend of the rate of production on that plot, an analysis of the results of the whole experiment fails to disclose a fundamental causation of this agreement, either in regard to the rate of production of the plots at a particular time, or from the stand-point of the rate of production of a particular species at any given period. That the latter does exert considerable effect at times is indicated by the high protein percentage of early spring herbage of which subterranean clover is the main constituent, but other influences as yet unidentifiable must be more potent still at times. A suggestion is that the ratio of leaf and stem of the grasses, which is largely affected by periodicities not coincident with those of the clovers, may have been particularly important in this respect.

Table 14.—Rate of Production of White Clover and Cocksfoot and Protein Content.

Waterings.	Rate of Production of—		Protein Percentage.
	White Clover.	Cocksfoot.	
6 of 3″ ..	1·73	·81	24·80
6 „ ..	4·20	·87	24·93
6 „ 5″ ..	2·44	·53	25·55
6 „ 6″ ..	2·57	·49	23·36
5 „ 6″ ..	2·26	·86	24·97
4 „ 6″ ..	·33	·24	24·90
3 „ 6″ ..	2·05	1·50	23·63
8 „ 3″ ..	5·68	1·15	25·17

Judged by the results obtained in sheep-feeding trials overseas, the herbage from all the plots must also have possessed a high degree of digestibility of its protein, fibre, &c. The palatability, in view of the variety of species occurring, must also have been of a high order. Since there is no suggestion that any one plot (excluding the unirrigated plot) suffered in feeding value as a result of the watering system employed, the conclusions already reached in regard to the suitability of the six waterings of 4 inches for pasture production remain unquestioned. In this plot we have a happy combination of yielding ability, persistency of desirable species, and outstanding nutritive value, together with a distribution of the annual production which approaches as closely as possible under Werribee conditions the ideal which appears as yet impossible of attainment. Advantageous modifications which can be induced in the production cycle of irrigated pasture by means of the superimposition of improved manurial practice and controlled grazing are being studied concurrently with the problem of watering, and it is hoped to present the results of these investigations at an early date, thus linking up in a series of comprehensive reports the analyses of the various phases of pasture production, maintenance, and utilization.

Permanent Pasture Establishment

(Continued from page 165.)

investigation. If used it should be applied in two dressings—one in the late autumn and the other in mid-winter, and may be expected to encourage grass development in particular. A further dressing of super. may be applied in the early spring to promote a flush of early spring growth and ensure firm establishment of the first year pasture.

With the field sown it only remains to manage it carefully, so that the work of establishment is not so much labour lost. The field should not be grazed before the roots are well established or the young plants may be pulled out of the ground. The time allowed for establishment depends very largely on the growing conditions which prevail from the time of sowing onwards, while the state of the ground at the time of the first grazing is also a matter for consideration. From three to four months is probably a safe estimate of time which should be allowed to lapse between sowing down and the first grazing.

When once started grazing should be carried out on the rotational system, and may be moderately heavy, provided fairly long periods of rest are given the pasture. This procedure ensures a strong tiller development in addition to keeping the grass young and growing, and in its most nutritious and palatable state. The yield of grass per acre will not be so heavy as with a less frequently grazed field, but the amount of digestible nutrients per acre, as indicated by the milk returns, will be greater.

It is advisable to harrow the field occasionally to break up and spread the cow pats and prevent any coarse and unpalatable growth from appearing.

With the rotational grazing system well established as a farm practice, the opportunity of cutting and conserving meadow hay or ensilage soon presents itself. As mentioned previously, the spring ushers in grass growth with which the present stock cannot cope. At this stage one or two paddocks can be closed to grazing and allowed to develop into a hay or ensilage crop, which if cut at the right time will produce a highly nutritious feed of value for the lean winter and summer months.

Farm Produce Agents

Part I.—List of Licences for the current year issued to 8th February, 1932.

Name of Licensee.	Court where Issued.
Acme Seed Store	Brighton
Anderson, David, and Co.	Horsham
Anderson, L. D., and R. S.	Prahran
Anderson, Leslie Wilson	Melbourne
Andrew, J., and Co.	Bendigo
Anguey, Robert	Melbourne
Anguey, William	Carlton
Aurora Packing Co. Ltd.	Melbourne
Austral Grain and Ambler Pty. Ltd.	Prahran
Australian Estates and Mortgage Co. Ltd.	St. Kilda
Australian Mercantile Land and Finance Co. Ltd.	Brighton
Baker, Robert	Northcote
Barbaro, Antonio	North Melbourne
Barrass & Co.	Bendigo
Barrow Bros. Commission Agency Pty. Ltd.	Melbourne
Barrow, H. R., and Sons	„
Beasley, Thomas	Werribee
Belcher, Norman, and Co.	Geelong
Best, Spalding, and Bell	Ararat
Bethune, Alexander Cecil	Lilydale
Bevis, Ralph Henry	Cheltenham
Bird, Henry William	Wedderburn
Blackham, W. H. Pty. Ltd. ..	Prahran
Booth, Frank, and Sons	Malvern
Borrett, J. R., Pty. Ltd.	Melbourne
Borwick, Peter S.	Colac
Bourke and Thewlis	Benalla
Box, Arthur D.	Frankston
Brown and Dureau Ltd.	Melbourne
Bryant and Gourley	Ballarat
Bungaree and District Co-operative Society Ltd.	Bungaree
Burns, J. J., and Co.	Geelong
Burns, Louis Edward	„
Butler and Moss (Thomas Brown Slaney trading as)	Caulfield
Campbell and Co.	Numurkah
Carter, H. R., and Co.	St. Kilda
Cashen, William Daniel	Wedderburn

FARM PRODUCE AGENTS—*continued.*

Name of Licensee.	Court where Issued.
Cavanagh, George	Camberwell
Cave, F., and Co. Pty. Ltd. ..	Lilydale
Charteris, George	Melbourne
Clements, C. E., and Co.	Melbourne
Cocks, Thomas James	Nathalia
Connaughton, John Patrick ..	Ballarat
Cooper, Edward	,,
Co-operated Dried Fruit Sales Pty. Ltd.	Melbourne
Cope, Henry Edward	
Cornish, R., and Son	Box Hill
Cowling, W.	Malvern
Cox, Colin	Bendigo
Crickard, F. B., and Co.	Bairnsdale
Cristofore, Matteo..	Melbourne
Curnow, J. H., and Son, Cyril James Curnow trading as	Nth. Melbourne
Dalgety and Co. Ltd.	Bendigo
Dalgety and Co. Ltd.	Flemington
Dalker, Edward	Geelong
Daniel and Andrews Pty. Ltd. ..	North Melbourne
Dedrick, P. A., and Co.	Sale
Dennis, William	Caulfield
Donnellan, Laurence	Bairnsdale
Drevermann, F. D., and Co. ..	Collingwood
Dreyfus, Louis, and Co.	Bairnsdale
Durant, T. W., and Son	Brighton
Dwyer, John Thomas	Nhill
Fairbridge & Kerr	Charlton
Falla and Pitty	Warrnambool
Fang Yock	Donald
Ferlazzo, Giovanni	South Melbourne
Ferris, Herbert	Essendon
Fiedler, J. H.	Kyneton
Foley Bros. Ltd.	Rochester
Fox, Edmund John	Melbourne
Foy, James Allen	Hawthorn
Fraser, H. L. C.	Malvern
Fysh, W. H., and Co.	Prahran
Geelong and Cressy Trading Co. Ltd.	Kyneton
Geraldton Fruit Co., Thomas Louey Wing trading as	Geelong
Gerrand, William	Melbourne
Gibbons, Reginald Leslie Alfred ..	
Gidley, John	Bendigo
Gippsland and Northern Co-operative Co. Ltd.	Shepparton
Glasson, P. J., and Co.	Melbourne
Goldsbrough, Mort, and Co. Ltd. ..	,,
Goulding, John F., Pty. Ltd. ..	
Gratsch, Frederick William ..	Horsham
Gray, J., and Co.	Melbourne
Gray, Montrose Lionel	Brunswick
Gray, W. H. & Son Pty. Ltd. ..	Horsham
Gregory and Son	Ballarat
Harris, William O. E.	Box Hill
Harrisons Ramsay Pty. Ltd. ..	Donald
Haughton, William, and Co. ..	Pyramid Hill
Haynes, E. R., Pty. Ltd.	Bairnsdale
Hayward, Samuel	Camberwell
Herrick and Williams	Melbourne
Hill and Read	Malvern
Hill, Harold Hereward	Beaufort
Hinch, Herbert	Rochester
Hocking, J., and Sons Pty. Ltd. ..	Brighton
Holden, Richard Herbert	Wangaratta
	Horsham
	Caulfield
	Lilydale

Name of Licensee.	Court where Issued.
Hurst, Evelyn Joseph	Geelong
International Fruit and Mercantile Co.	Melbourne
Johnson, Alexander Keith	Brighton
Keast, H. R., and Co.	Caulfield
Kilpatrick, McLennan, and Co. ..	Numurkah
Kilroy and Storey	Heathcote
Kimberley, John, and Sons.. ..	Horsham
King and Heath	Bairnsdale
Kirkwood, John	Melbourne
Kwong Hoong Wah	,,
Lawless, T. J., and Co.	Ballarat
Ledger, Wann, and Co., Herbert ..	Benalla
Leong Hoong Cheong	Melbourne
Lister, Geo. Pty. Ltd.	,,
Lorimer Bros.	St. Arnaud
Louey Pang, H., and Co. Pty. Ltd. ..	Melbourne
Lowen, Harold William	Melbourne
Lucas, Denis	North Melbourne
Lum, H., and Co.	Melbourne
Lyall, Robt. and Sons Pty. Ltd.	North Melbourne
Mills, Leslie Frederick	Horsham
Mitchell, Bellair, and Lees	Melbourne
Mitchell, James Milne	Lilydale
Montgomery and Bradshaw ..	Terang
Morgan, William Arthur	Donald
Morrison & Fraser	Bairnsdale
Morton, T. R. B., and Son	Melbourne
Moss, J., and Sons	Caulfield
Muir, Andrew Stewart	Kerang
Must, Frank	Malvern
McCarthy, George	Carlton
McClure, Robert G.	Cobden
McColl and Buzza	Northcote
McDonnell, Thomson, and Williamson Pty. Ltd.	Box Hill
McGuffie, William Anthony ..	Charlton
McHugh, T., Ltd.	Melbourne
McKeever and Co.	,,
McLean, A., & Co.	Bairnsdale
McNamara, J., and Co. ..	Numurkah
McPhail, Anderson, and Co. ..	Melbourne
McRae, John, and Sons	Horsham
Nash, Stanley	Geelong
New Zealand Loan and Mercantile Agency Co. Ltd.	Malvern
Newton and Miller	Horsham
Norris and Wilkinson	Brunswick
North-Eastern Co-operative Society Ltd.	Wangaratta
Nuttall, Clark, and Co.	Bendigo
O'Donnell, F. M., and Co. ..	Birchip
Onians, R. and A., Pty. Ltd. ..	Malvern
Overton, Ernest Alfred	Lilydale
Pack Kee	Melbourne
Parer, Salvador	,,
Parkes, Thomas Ernest	South Melbourne
Patrikeos, Peter Andrew	Hawthorn
Pay, Ernest	Kerang
Peachey, R. A., Pty. Ltd.	St. Kilda
Pitcher, William	Dandenong
Pitt, A. E.	Brunswick
Plant, Rolla Thomas	Horsham
Potter Bros.	Bendigo
Price, Arthur Isaac	Melbourne
Producers Co-operative Distributing Society Ltd.	,,

FARM PRODUCE AGENTS—*continued.*

Name of Licensee.	Court where Issued.	Name of Licensee.	Court where Issued.
Pyramid Co-operative Society Ltd. ..	Pyramid Hill	Tweedie, Walter Herbert	Ballarat
Quong Hie Shing	Melbourne	Tyner, W., Pty. Ltd.	Caulfield
Rasmussen Bros., Arthur Beckham trading as	Bendigo	Vaughan, Chas., and Co.	Ballarat
		Vawdrey, William	Geelong
Read, Hubert Lindsay	Lilydale	Vear, F. W.	Melbourne
Reilly, Vincent Osmond	Essendon	Victorian Butter Factories Co-operative Co. Ltd.	Northcote
Renouf, Robert	Melbourne		
Richardson, A., and Co.	Essendon	Victorian Producers Co-operative Co. Ltd.	Eltham
Richardson H. F., and Co. ..	Geelong		
Robertson and Gardner	Brighton	Wade, H. M., and Co.	Caulfield
Robertson, E. C., Pty. Ltd. ..	Essendon	Wallis, Harold O.	Melbourne
Rodd, W. H. A., and Sons	Dandenong	Ward, H. S. K., Pty. Ltd.	St. Kilda
Royle and Bertram	Essendon	Watkins, William A.	Melbourne
Rush, Edward Reynolds	Malvern	Watts, Turnbull, and Co.	Benalla
Saltau and Son Pty. Ltd.	Warrnambool	Weddel, W., and Co. (Australia) Pty. Ltd.	Kew
Sam Yick, Susan Kenn trading as ..	Melbourne		
Sawyer and Devlin	Horsham	Wesley, John Henry	Bendigo
Schutt and Barrie Pty. Ltd. ..	Footscray	Western District Co-operative Produce and Insurance Co. Ltd.	Melbourne
Scott and Hines	Camberwell		
Shea, Hood, and Co. Pty. Ltd. ..	Essendon	Wilson and Frazer Pty. Ltd. ..	Carlton
Sheahan, P., and Co. Pty. Ltd. ..	Brighton	Wilson, Bolton, and Co.	Horsham
Shingles, Walter	Maffra	Wilson, Herbert, Pty. Ltd. ..	Melbourne
Smith, Arthur Brook	Melbourne	Wing Hie and Co., George Shee trading as	,,
Smith, Robert, Produce Pty. Ltd. ..	Camberwell		
Stellato, Louis	Melbourne	Wing Hing Loong	,,
Stewart, Porteous, and Co.	Essendon	Wing, R. A. and Co. ..	,,
Strachan and Co. Ltd.	Geelong	Wing, Young and Co.	,,
Sturken, John Ferdinand	Berwick	Wingfield, Ethel Harriet	Charlton
Sun Yee Lee	Melbourne	Wood, C. H., and Co.	Melbourne
Taylor, John Crampton	Camberwell	Wright, J. W., and Co.	Elmore
Till, Henry	Melbourne	Yee Tong, Ronald	Melbourne
Timmins, Dudley Edward	Bruthen	Young Bros.	Horsham
Tinney Bros.	Bungaree	Young, J. H., and Co.	Caulfield
Todd, James A.	Hawthorn	Young, Tim and Co., Pty. Ltd. ..	Brunswick
Tuck, Walter Stanley	Cobram		

Part II.—List of Licences for the current year issued to 18th March, 1932.

FARM PRODUCE AGENTS.

Name of Licensee.	Court where Issued.	Name of Licensee.	Court where Issued.
Associated Butter Factories Pty. Ltd.	Melbourne	Mentiplay, D., and Co. ..	Melbourne
Bell, Banson Pty. Ltd.	,,	McLean, N. N., Pty. Ltd.	,,
Brophy, Foley, and Co.	Ballarat	North Western Fruitgrowers Ltd. ..	Ballarat
Chinn, F. A., and Co.	Melbourne	Norton, Ernest A.	Shepparton
Dunstan, Alfred Charles	Ferntree Gully	Orlando, Antonio	North Melbourne
Ebbott, Kebby Pty. Ltd.	Melbourne	O'Toole, Hugh Joseph	Warrnambool
Goulding, John W.	,,	Parsons, Robert	Caulfield
Green, Thomas C.	Bunyip	Ross, J. W., John William Mason trading as	Melbourne
Greenfield, A. M., and Co. ..	Ballarat		
Hanger and Krerouse Pty. Ltd. ..	Melbourne	Sang Goon and Co.	,,
Hecht, H., and Co.	,,	Scott, Alex., and Co. Pty. Ltd. ..	Dandenong
Hook Yick & Co., Geo. Kitts trading as	,,	Toy Yeuck	Melbourne
Jukes, John R.	Maryborough	Victorian Fishermen's Association ..	,,
Lewis, John William	Warburton	Wellman, Austin H.	North Melbourne
Low, James Lindsay	Lilydale	Wong Hee, C., and Co.	Melbourne
Man Hop	Melbourne		

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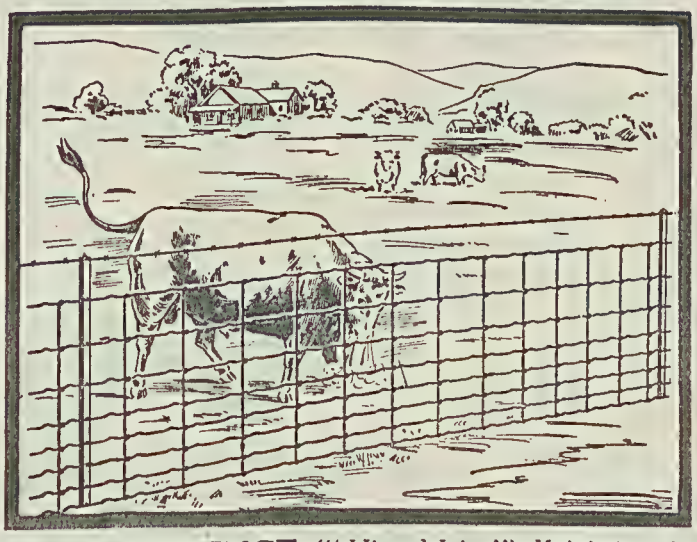

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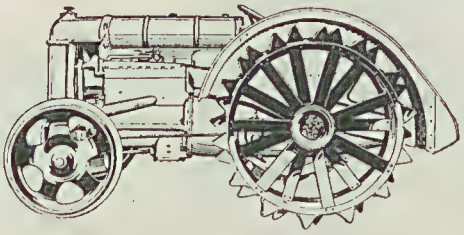

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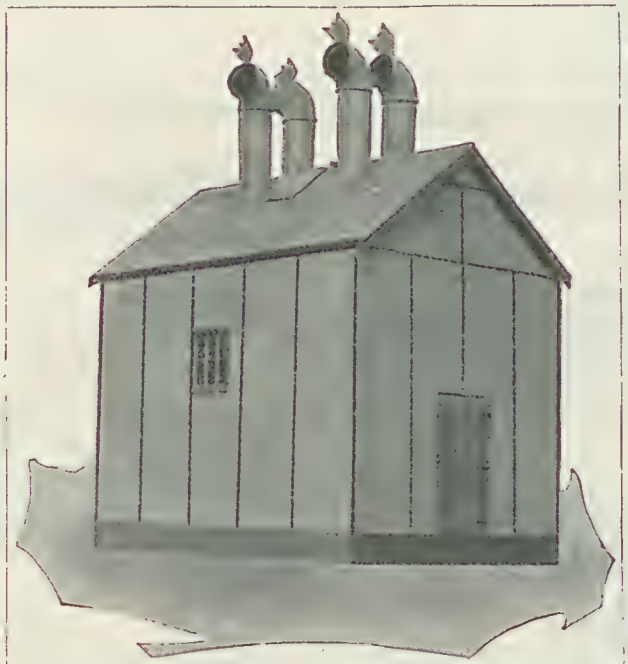

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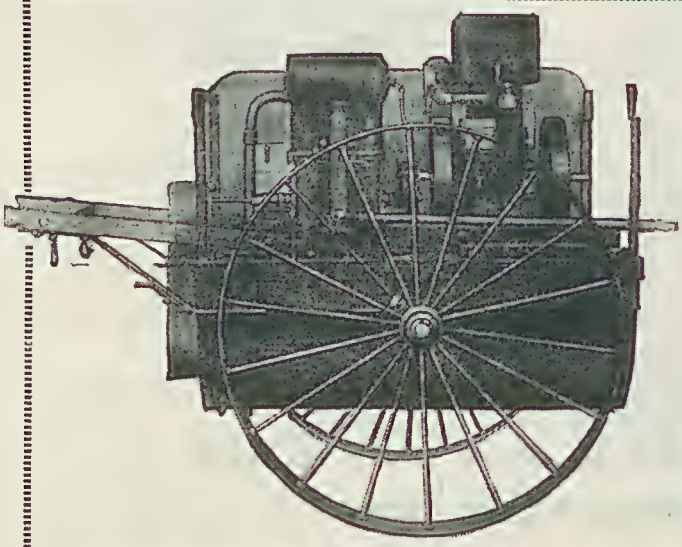

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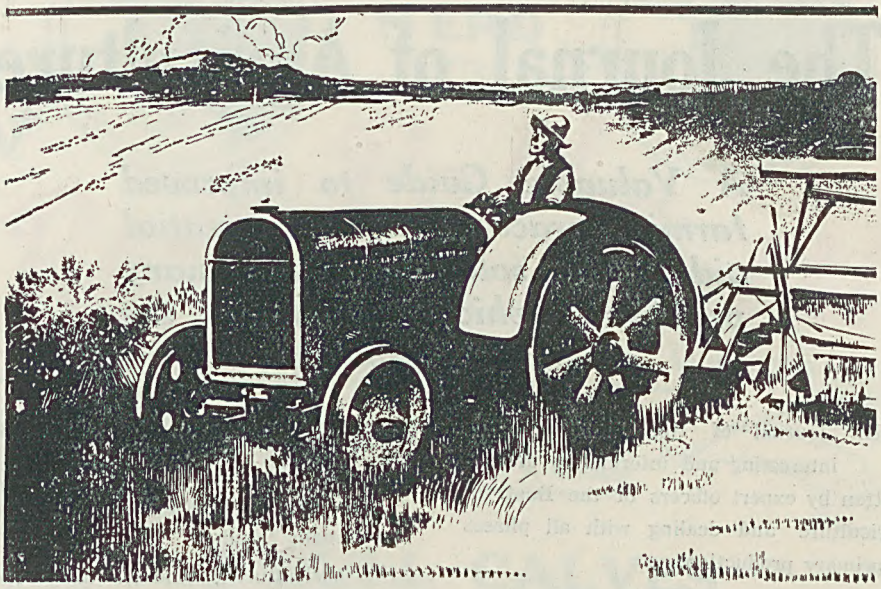

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